CSAH 34 and TH 24 form a bypass of downtown Litchfield for vehicles that can't make the tight turn on TH 12. Southbound traffic at the study intersection experiences delays at peak traffic times. MnDOT planned to implement an offset westbound right-turn lane at this intersection but wanted to complete a formal intersection control evaluation (ICE) to understand both safety and operational issues to enable planning for the ultimate improvement.

The study included safety and operational analysis (using Synchro/SimTraffic) following the ICE process, which looked at shorter-term/less-costly improvements and longer-term/ultimate solutions. Reduced conflict intersections, including a Reduced Conflict U-turn Intersection (RCUT), were investigated along with more traditional traffic control solutions. Additionally, the study identified frontage road improvements along the north side of TH 12 that would provide local trips a route off the trunk highway system.

The ICE Report document is included on the following pages.

Intersection Control Evaluation Report

TH 12 at CSAH 34

City of Litchfield, MN

March 30, 2017
S.P. 4705-45
BMI Project Number T42.M00040

DEPARTMENT OF TRANSPORTATION

BOLTON & MENK

Real People. Real Solutions.

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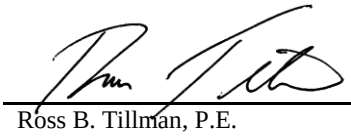
Intersection Control Evaluation

TH 12 at CSAH 34

in

City of Litchfield, Meeker County

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.



Ross B. Tillman, P.E.	51692	March 30, 2017
	Reg. No.	Date

EXECUTIVE SUMMARY

The intersection of TH 12 & CSAH 34 is an existing 3-legged side street stop controlled intersection located within the City of Litchfield, MN. This location has been identified by MnDOT District 8 as being a sustained crash location. The purpose of this study is to identify different traffic control alternatives and frontage road considerations to improve safety and traffic operations.

A traffic analysis was completed using existing (2016) and design year (2036) traffic volumes for the existing roadway/intersection geometry and various design alternatives. Future traffic volumes were forecast using a combination of historical traffic volumes, the 2008 Litchfield Transportation Plan, and the Meeker County Projection Factor.

Traffic signal and all-way stop control warrants were considered using both the 2016 and 2036 projected traffic volumes. No signal warrants are met in 2016. In 2036, the project traffic volumes are expected to exceed thresholds for warrant 1B, 2 and 3. A regression analysis was completed determining that warrant 1B is likely to be met in approximately 10 years based on anticipated traffic growth. All way stop control warrants are not met.

The traffic control alternatives analyzed for safety and operational impacts include:

- No build (existing side street stop control)
- Adding turn lanes (on CSAH 34 and converting left turn bypass to a left turn lane on TH 12)
- Traffic signal
- Single-lane roundabout
- Green “T” traffic signal
- Reduced conflict intersection (RCI)
- Right-in/right-out (RIRO)

All alternatives are anticipated to operate adequately with 2016 traffic volumes, however the no build, adding turn lanes, RCI, and RIRO alternatives operate at LOS D or worse in the design year in the PM peak hour.

Intersection safety was reviewed using 2013-2015 crash data and shows the existing intersection operating over the critical rate for similar intersections statewide. The number of crashes occurring at this location is more than expected. Each alternative was analyzed for potential impacts to the intersection crash rate using appropriate crash modification factors.

Lastly, cost estimates were determined for the feasible alternatives given warrant analysis results and additional factors such as access.

In summary, a phased approach to enhancing this intersection has been determined to be most appropriate. See Table I for a high level summary of each alternative considered. MnDOT is currently planning to construct an offset right similar to what is built at the intersection of TH 12 and Johnson Drive. Conversion of the existing bypass lane on eastbound TH 12 to a left turn lane should be considered as well. Designated turn lanes on CSAH 34 could be striped at this time to allow for right turning vehicles to bypass vehicles waiting to turn left.

With an initial safety improvement constructed, the focus should shift to further developing and planning for the construction of an improved frontage road/local road system including frontage and/or backage road connections from west of CSAH 34 to the Johnson Drive area. ent is a frontage road alignment is ultimately constructed.

Lastly, a long-term traffic control/intersection vision should be determined.

MnDOT should continue to monitor the TH 12/CSAH 34 intersection for changes in operations and safety as they relate to a long-term solution. Because thru-stop control with turn lanes is expected to break down as traffic levels increase, a higher level of traffic control or other intersection geometry change is expected to be needed in the future.

Table I: Summary Matrix

Intersection Modification	2016 Intersection LOS (AM/PM)	2036 Intersection LOS (AM/PM)	Expected Crash Rate	Estimated Construction Cost
No Build	A/B	C/F	0.80	N/A
Add Turn Lanes	A/B	C/F	0.45	$ 525,000.00
Traffic Signal	A/B	B/B	0.53	$ 725,000.00
Roundabout	A/B	B/C	0.22	$ 1,500,000.00
Green "T"	B/B	B/C	0.40	$ 1,625,000.00
Reduced Conflict Intersection (RCI)	C/C	C/D	0.58	$ 2,125,000.00
Right-in/Right-out (RIRO)	C/C	C/D	0.30	*

*Cost not computed. Alternative does not meet the access needs of the area and removed from consideration.

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INTERSECTION CONTROL EVALUATION

INTRODUCTION

The Minnesota Department of Transportation (MnDOT) District 8, Meeker County, and the City of Litchfield coordinated on the development of this Intersection Control Evaluation (ICE), which considers improvements to the intersection of TH 12 and County State Aid Highway (CSAH) 34. The City of Litchfield – a community of approximately 6,700 people – is located in south-central Minnesota (see the study area in **Figure 1**).

This ICE report documents the evaluation of potential intersection alternatives, and local roadway improvement considerations that have potential to affect TH 12/CSAH 34 intersection operations. This report does not recommend a specific vision for the intersection; rather, options for intersection and local roadway improvements so that MnDOT, Meeker County, and the City of Litchfield can identify an intersection alternative or incremental fixes as needed based on potential options.

NEED FOR TH 12/CSAH 34 ICE

MnDOT District 8 has identified the TH 12 and CSAH 34 intersection as a sustained crash location. A substandard frontage road that ties into CSAH 34 roughly 100 feet north of the TH 12 intersection complicates operations.Traffic bound for commercial properties east of CSAH 34 - including the Wal-Mart Supercenter approximately one-half mile east of the intersection - must use TH 12 to complete these trips, because the local street network does not connect to the store. The City has expressed the need for a local street connection to the Wal-Mart Supercenter.

Through discussions with Meeker County and City of Litchfield staff, MnDOT opted to consider innovative solutions to address crashes at TH 12 and CSAH 34, including:

- Intersection configurations
- Rerouting the frontage road immediately northwest of the intersection, and
- Local street network modifications to provide alternative access to commercial properties east of CSAH 34, including the Wal-Mart Supercenter

The purpose of this ICE report is to evaluate the ability of intersection alternatives to address existing issues at the intersection of TH 12 and CSAH 34. The report also addresses how frontage road and local street network modifications would interact with each viable intersection alternative. This ICE report documents the following items:

- Existing Conditions
- Alternatives Considered
    - Intersections
    - Frontage/Local Road System
- Warrant Analysis
- Crash Analysis
- Operational Analysis
- Other Considerations

Rather than document one recommended alternative, this ICE report provides a range of options. Recommendations to eliminate some of these options are made based on performance measures. What remains is a viable set of options that could be implemented to address: short-term

intersection improvements; long-term traffic control needs; and frontage road/local street connectivity.

EXISTING CONDITIONS

Physical Attributes

TH 12 is a principal arterial that cuts a diagonal through Litchfield. CSAH 34, a two-lane north-south major collector, intersects the north side of TH 12. TH 12 and CSAH 34 create a 3-legged, stop controlled intersection, with CSAH 34 extending north from TH 12. There are no designated turn lanes on CSAH 34. The posted speed limit on TH 12 is 45 mph (see **Figure 1**).

Westbound TH 12 has one through lane and one right turn lane. Eastbound TH 12 has one through lane and a left turn bypass for when eastbound vehicles are stopped to turn left (north) onto CSAH 34.

A frontage road paralleling the north side of TH 12 between Precision Drive and CSAH 34 provides access to several businesses. This frontage road intersects CSAH 34 roughly 100 feet north of TH 12. The close proximity of this road complicates operation of the intersection.

260th Street/Ripley Street runs east-west, and passes near the north side of the Wal-Mart Super Center, approximately 1,900 feet north of the TH 12 and Johnson Drive intersection. Johnson Drive terminates south of 260th Street/Ripley Street.

The northern intersection quadrants are zoned for retail/commercial or industrial uses. The Wal-Mart Supercenter is located approximately one half mile east of the TH 12/CSAH 34 intersection. The only access to this major traffic generating land use is from TH 12 at Johnson Drive.

Traffic Volumes

Volumes on TH 12 in the vicinity of the intersection with CSAH 34 were between 5,800 and 8,600 vehicles per day in 2015; volumes on CSAH 34 were 3,850 vehicles per day in 2015 (MnDOT Traffic Data). 13-hour traffic counts of the intersections listed below were conducted in September 2016:

- TH 12 and Johnson Drive
- TH 12 and CSAH 34
- CSAH 34 and 260th Street/Ripley Street

Figure 2 shows the peak hour turning movement counts/volumes. The 13-hour turning movement count at these intersections is provided in **Appendix A**.

FUTURE CONDITIONS

Traffic volumes were forecast for 2036 (20-year projection) based on multiple factors and sources of data including:

- Historical Volumes: 2.5%/year on TH 12 and 0.3%/year on CSAH 34
- Litchfield Transportation Plan: 2.5%/year on TH 12, 3%/year on CSAH 34
- County Projection Factor: 0.5%/year on both roadways

The historical volume trend matches what was assumed in the Transportation Plan. The plan accounted for specific land use trends and census data. The higher, yearly traffic volume growth rate for CSAH 34 from the Transportation Plan seemed to assume more localized development on that route; this growth has not occurred since completion of that plan.

Based on these considerations, 2036 traffic volumes for this ICE Report were developed using a 2.5%/year growth rate on TH 12 and a 0.5%/year growth rate along CSAH 34. The adjusted rate on CSAH 34 ties both the historical trends and projection factor together. 2036 peak hour turning movement volumes are shown on **Figure 3**.

SIGNAL WARRANT ANALYSIS

Based on the 2016 and forecasted 2036 traffic volumes, a traffic signal warrant analysis and an all way stop warrant analysis was conducted using the warrants outlined in the most recent Minnesota Manual on Uniform Traffic Control Devices (MnMUTCD). The signal warrant analysis allows a reduction in the traffic volumes when the posted speed limit is greater than 40 mph or the population of the community is less than 10,000 people. The 70 percent factor was applied to the signal warrant analysis and all-way stop analysis since Litchfield's population is less than 10,000 people and speeds are greater than 40 mph on TH 12.

Traffic Signal & Roundabout Warrant Analysis

The MnMUTCD states traffic control signal need analysis shall include consideration of applicable factors contained in these traffic signal warrants:

- Warrant 1: Eight-Hour Vehicular Volume
  - 1A: Minimum Vehicular Volume
  - 1B: Interruption of Continuous Traffic
- Warrant 2: Four-Hour Vehicular Volume
- Warrant 3: Peak Hour
- Warrant 4: Pedestrian Volume
- Warrant 5: School Crossing
- Warrant 6: Coordinated Signal System
- Warrant 7: Crash Experience
- Warrant 8: Roadway Network
- Warrant 9: Intersection Near a Grade Crossing

Based on the results of the 2016 traffic signal warrant analysis, the intersection of TH 12 and CSAH 34 does not satisfy any warrant. Warrant 7 is met from a volume perspective however five or more correctable crashes by a traffic signal have not occurred in a twelve-month period. For 2036, the intersection satisfies Warrants 1B, 2, and 3. Based on the anticipated traffic growth rates, Warrant 1B is expected to be met in approximately 10 years. Traffic signal warrant analyses for 2016 and 2036 are in **Appendix B**.

Roundabouts are considered to be warranted by MnDOT if warrants are met for either traffic signals or all way stop control. Because warrants are met for a traffic signal, warrants are considered to be met for a roundabout at the TH 12 and CSAH 43 intersection.

While warrants for a traffic signal and roundabout are met, additional engineering study must be completed to determine if a signal or roundabout would improve the overall intersection safety and operations and not disrupt traffic flow. Additional consideration of these issues is provided below as part of crash and operational analyses.

All Way Stop Control Warrant Analysis

All Way Stop Control (AWSC) can be useful as a safety measure at intersections if safety concerns exist because of high traffic volumes in multiple directions or if there is insufficient sight distance available to see conflicting traffic on an approach to an intersection. The

MnMUTCD states that the need for an AWSC shall be considered if one of the following conditions are met:

- Condition A: Where traffic control signals are justified, an all-way stop can be installed as an interim measure.
- Condition B: Five or more crashes are reported in a 12-month period that are susceptible to correction by an all-way stop installation. Such crashes include right-turn, left-turn, and right-angle collisions. For roundabouts, such crashes include right-angle, right/left turn, and head on collisions.
- Condition C: The volume of either vehicles or a combination of vehicles, pedestrians and bicycles entering the intersection from all approaches for any 8 hours of an average day meets the minimum volume requirement set forth in section 2B.7 of the MnMUTCD.

Traffic volumes on the CSAH 34 approach are too low to meet Condition C (see **Appendix B** for the results of the all way stop warrant analysis for condition C) and five or more correctible crashes were not reported. Though Condition A is met, installing an all-way stop at this location would unnecessarily stop mainline TH 12 (a principal arterial roadway focused on providing regional mobility) traffic at all times, even when not needed to provide gaps for side street traffic. For this reason, an all-way stop at this location was not further analyzed.

ALTERNATIVES CONSIDERED

TH 12/CSAH 34 intersection alternatives as well as frontage road and local street connector alternatives were considered during this process. For comparative purposes, the performance of intersection alternatives was compared against the performance of the No-Build Alternative.

No-Build Alternative

The No-Build Alternative would retain the current two-way stop control at the TH 12 and CSAH 34 intersection. No frontage road or local street improvements are included in this alternative.

TH 12/CSAH 34 Intersection Alternatives

This section describes TH 12 and CASH 34 intersection alternatives, including:

1. Addition of Turn Lanes (both on TH 12 and CSAH 34)
2. Traffic Signal Control
3. Single Lane Roundabout
4. Green “T” Intersection
5. Reduced Conflict Intersection
6. Right-in/Right-out (RIRO) Intersection

Each alternative is described below; geometric layouts for each alternative are shown on **Figures 3-9**. Planning level costs are also provided for each alternative based on the completed concept drawings.

*1. Turn Lanes Alternative (see **Figure 4**)*

Turn lanes can improve intersection safety and operations by removing stopped vehicles from through lanes of traffic. MnDOT Road Design Manual and also the MnDOT Access Management Manual includes guidance for installing turn lanes. In the case of this location, both right and left turn lanes meet warrants for installation.

Designated left-turn and right-turn lanes were considered at the intersection. The designated left turn lane from eastbound TH 12 onto northbound CSAH 34 converts the existing bypass lane into

a left turn lane. Left and right turn lanes from southbound CSAH 34 onto TH 12 were also considered.

*2. Traffic Signal Control Alternative (see **Figure 5**)*

A traffic signal can address operational issues and improve mobility. Advantages of a traffic signal include reducing delay for specific traffic movements, provide safer passage for pedestrian and bicycle movements and providing pre-emption for emergency services if devices are installed. This alternative also included the turn lanes described in alternative 1.

*3. Roundabout Alternative (see **Figure 6**)*

Benefits of roundabouts include:

- Efficient traffic operations
- Low severity crashes due to shallow entry angle
- Natural speed reductions, due to approach curvature
- Fewer conflict points than traffic signal or all way stop control
- Safe handling of U-turns
- Potential to minimize width of approach legs (by removing dedicated turn lanes if present)

A three-legged roundabout alternative was developed for the TH 12/CSAH 34 intersection. This intersection design would eliminate turn lanes on TH 12. The design of this alternative accommodates trucks carrying oversized loads in all directions of the intersection.

*4. Continuous Green T-intersection (CGT) (see **Figure 7**)*

The CGT design allows main line through traffic furthest from the side street to pass through a signalized intersection without stopping (the top side of the "T", in this case eastbound TH 12, while eliminating conflicting vehicular movements. With a CGT, the through movement on the main line approach to the intersection is denoted by a steady green arrow traffic signal and pavement markings or other lane delineation devices, so left-turning traffic stays in its respective lane. Left turning traffic onto TH 12 from CSAH 34 turns into an acceleration lane prior to merging into the main through lane at higher speeds to the east.

The CGT is an appropriate consideration for intersections with three approaches, moderate-to-low left-turn volumes from the cross-street, and high arterial through volumes (source: FHWA http://safety.fhwa.dot.gov/intersection/innovative/others/casestudies/fhwasa09016/, accessed December 2, 2016). For the TH 12/CSAH 34 intersection, an alternative was developed that allows through TH 12 traffic to travel unimpeded, while the movement of turning vehicles would adhere to the new traffic signal.

*5. Reduced Conflict Intersection (see **Figure 8**)*

Reduced conflict intersections (RCIs) eliminate left turns from the minor road onto the major road, as well as the ability to travel directly across the major roadway. Drivers on the minor road desiring to go through the intersection, or go left, travel along the major roadway to a designated U-turn location; upon making the U-turn the driver can continue on the major road, or can turn right onto the minor roadway, thereby crossing the intersection (no crossing required at TH 12/CSAH 34).

*6. Right-in/Right-out (RIRO) Intersection (see **Figure 9**)*

This type of intersection permits access between the mainline highway and the intersecting roadway via right-turn movements only. Left-turn movements are not permitted. The RIRO treatment is use to address safety and operational concerns where other intersections nearby are

able to accommodate missing movements. This intersection serves as a primary access connection between the County and Trunk Highway systems, a RIRO is not recommended at this location.

OPERATIONAL ANALYSIS

Analysis was completed for both the AM and PM peak hours using the turning movement counts collected in 2016 and the forecast developed for the design year of 2036. The analysis was performed using the methodology of the 2010 Highway Capacity Manual through Synchro/SimTraffic, a traffic analysis software program by Trafficware, for existing conditions as well as the various alternatives. To measure level of service and delay for the roundabout, the Highway Capacity Manual roundabout delay equation was used. This equation compares entering volumes to conflicting circulating volumes to determine effective capacity. Results of the analysis are displayed as measures of effectiveness.

Measures of Effectiveness

Measures of effectiveness display quantitative information about the performance of an intersection or network of intersections.

Level of Service (LOS)

The LOS and associated intersection delay for signalized and unsignalized intersections is shown in **Table 1**. Because drivers typically expect a higher LOS at stop-controlled intersections, the delay threshold unsignalized intersections is lower than for signalized intersections at LOS B and lower. Roundabouts can be compared against either signalized or unsignalized intersections. For this study, roundabouts were evaluated against unsignalized intersections since the existing intersection is unsignalized.

Table 1: Level of Service Criteria

	Signalized Intersection	*Unsignalized Intersection*
LOS	**Control Delay per Vehicle (sec.)**	**Control Delay per Vehicle (sec.)**
A	≤ 10	≤ 10
B	>10 and ≤ 20	>10 and ≤ 15
C	>20 and ≤ 35	>15 and ≤ 25
D	>35 and ≤ 55	>25 and ≤ 35
E	>55 and ≤ 80	>35 and ≤ 50
F	>80	>50

Queuing

Traffic backups (queues) are also used to indicate how well certain types of traffic control and intersection configurations operate. Table 2 shows both average and max queues are measured based on the analysis. As indicated in the results, most alternatives have either average or max queues for southbound traffic that extend past the existing frontage road connection. Queuing through intersections can cause additional delay for drivers on the frontage road and can also block sight lines for drivers trying to make left turns. All intersection control alternatives are still viable based on this information, however the location of the frontage road relative to TH 12 should be adjusted to account for these queue lengths.

As shown in **Table 1**, the No-Build and the Turn Lanes Alternatives for the TH 12 and CSAH 34 intersection are anticipated to operate at LOS F during the PM peak hour in 2036, with over six minutes of delay for southbound traffic. Because of this delay and the resulting LOS, it is recommended that if either the No-Build or the Turn Lane Alternatives are selected for the short-

term, that plans are in place to change the intersection control before LOS F is experienced by drivers on an ongoing basis.

Both the RCI and the RIRO Alternatives for the intersection would operate at LOS D in the PM peak hour in 2036, with over two minutes of delay. LOS E is regarded as an acceptable design year LOS, therefore, both of these alternatives could continue to be considered as long-term options.

Complete traffic operation analysis results are provided in **Appendix C**.

Table 2: Traffic Operations Measures of Effectiveness for Intersection Control Types, 2016 and 2036

Intersection Modification	Access	Peak Hour	LOS	Maximum Delay (sec)	SB Average Queue Length (ft.)	SB Maximum Queue Length (ft.)
Build Year 2016 Measures of Effectiveness by Alternative						
No Build	**Full**	AM	A	10	43	74
		PM	B	14	53	123
Add Turn Lanes	**Full**	AM	A	10	33	67
		PM	B	14	37	91
Traffic Signal	**Full**	AM	A	9	33	73
		PM	B	11	35	75
Roundabout	**Full**	AM	A	7	-	25
		PM	B	10	-	25
Green "T"	**Full**	AM	B	16	38	76
		PM	B	19	47	106
Reduced Conflict Intersection (RCI)	**Partial**	AM	C	32	33	65
		PM	C	34	42	100
Right-in/Right-out (RIRO)	**Partial**	AM	C	32	34	70
		PM	C	34	41	87
Design Year 2036 Measures of Effectiveness by Alternative						
No Build	**Full**	AM	C	22	60	136
		PM	F	228	279	591
Add Turn Lanes	**Full**	AM	C	22	46	111
		PM	F	208	170	418
Traffic Signal	**Full**	AM	B	12	48	93
		PM	B	19	45	118
Roundabout	**Full**	AM	B	12	-	25
		PM	C	25	-	50
Green "T"	**Full**	AM	B	19	43	96
		PM	C	28	65	158
RCI	**Partial**	AM	C	35	37	67
		PM	D	41	56	150
Right-in/Right-out (RIRO)	**Partial**	AM	C	35	39	78
		PM	D	45	63	187

CRASH ANALYSIS

TH 12 and CSAH 34 intersection crash data was analyzed using the Minnesota Crash Mapping Analysis Tool (MnCMAT) for the three year period, 2013-2015. This analysis compares actual intersection crash rates[1] against critical crash rates[2] to determine if there is a safety issue at an intersection.

Between 2013 and 2015, eight crashes were reported at the intersection of TH 12 and CSAH 34 consisting of:

- 4 rear end
- 4 left turn

The collision diagram illustrating details of these crashes is included in **Appendix D**.

The total crash rate for the TH 12 and CSAH 34 intersection was calculated to be 0.80 crashes per million entering vehicles (MEV) and the critical total crash index is 1.36. A critical index of less than one demonstrates that the intersection operates within the normal range. The index is greater than one, as in this case, indicates that the intersection operations operates outside the expected, normal range compared to similar intersections throughout the state. The critical index for fatal and severe injury crashes is zero as no fatal or severe injury crashes occurred at this intersection in the analyzed period.

An analysis was also done to determine the expected number of crashes per year at the TH 12 and CSAH 34 intersection for each intersection traffic control alternatives. The results are shown in **Table 3**.

[1] The crash rate is the number of crashes per million entering vehicles (MEV).

[2] The critical crash rate is a statistical comparison of the actual crash rate against similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside of the expected, normal range.

Table 3: Crashes Expected at TH 12 and CSAH 34 Intersection, by Traffic Control Type

2016 Annual Traffic Entering Traffic (MEV)		3.33 million entering vehicles per year
Traffic Control Type	**Crash Rate***	**Predicted Number of Crashes per Year**
No Build	0.80	2.7
Turn Lanes	0.45	1.5
Traffic Signal	0.53	1.8
Roundabout	0.22	0.8
Green "T"	0.40	1.3
Reduced Conflict Intersection	0.58	2.0
Right-in/Right-out	0.30	1.0

* Crash Rates calculated based on 2013-2015 data combined with relevant CMF from below.

Rates were determined based on 2013-2015 crash data and were adjusted for each alternative based on Crash Modification Factors (CMFs) from the CMF Clearinghouse. The following CMFs were used:

- 253: Provide a Left-Turn Lane on One Major-Road Approach
- 206: Convert Stop Controlled Intersection to Single-Lane Roundabout
- 5525: Install a Traffic Signal
- 5555: Install a RCI

ACCESS MANAGEMENT - FRONTAGE ROAD/LOCAL STREET CONNECTIONS

Access Management is a set of techniques that State and local governments can use to control access to highways, major arterials, and other roadways. The benefits of access management include improved movement of traffic, reduced crashes, and fewer vehicle conflicts.

The close spacing of the existing frontage road (between Precision Drive and CSAH 34) to the TH 12 and CSAH 34 intersection complicates traffic operations. East of CSAH 34, an incomplete frontage road provides only limited access to some businesses.

For this study, access management strategies were considered to provide local street connections to traffic bound for commercial properties east of CSAH 34 including the Wal-Mart Supercenter. Providing a local street network connection to these locations could reduce traffic at the TH 12/CSAH 34 intersection. The three conceptual options considered as part of this report are described below and shown on **Figure 10**.

*Option 1, Realigned TH 12 Frontage Road, 260th Street Improvements, & Johnson Drive Extension to 260th Street (see **Figure 10**)*
This option would provide a complete local road connection between the east and west sides of CSAH 34 via a new frontage road alignment west of CSAH 34, an improved 260th Street, and an extension of Johnson Drive to 260th Street. The new frontage road would tie into CSAH 34 on the back side of the Consumers' Co-op, located in the northwest corner of the TH 12/CSAH 34 intersection. Local traffic - including that destined for the Wal-Mart Supercenter - could utilize the realigned frontage road, CSAH 34, 260th Street, and then a new extension of Johnson Drive to access the store.

*Option 2, Realigned TH 12 Frontage Road behind Existing Businesses (see **Figure 10**)*
This option would move the existing frontage road located west of CSAH 34 to the back side of the Consumer's Co-op property and continue this road on the backside of the commercial property located on the northeast quadrant of the TH 12/CSAH 34 intersection. The frontage road would then tie into an existing portion frontage road, and finally be extended to Johnson Drive complete a local network connection to the Wal-Mart Supercenter. This option would provide a complete frontage road connection on both sides of CSAH 34.

*Option 3, Realigned TH 12 Frontage Road in front of Existing Businesses (see **Figure 10**)*
This option would extend the existing frontage road located west of CSAH 34 (on the front side of the Consumer's Co-op property), across CSAH 34 tie into an existing portion frontage road, and finally be extended to Johnson Drive complete a local network connection to the Wal-Mart Supercenter. This option would provide a complete frontage road connection on both sides of CSAH 34.

Moving the frontage road intersection with CSAH 34 away from its existing location could improve operations and safety at the Intersection of TH 12 and CSAH 34. The realigned frontage road options could operate with any of the TH 12 and CSAH 34 intersection modification alternatives that are under consideration. However, the close proximity of the Option 3 frontage road to the existing TH 12 and CSAH 34 intersection may yield continued intersection operation issues. From the perspective of TH 12/CSAH 34 intersection operations, Options 1 and 2 are more optimal than Option 3.

All options would improve the local street network connection so that local traffic would not be required to travel on TH 12 to access businesses located in the east end of town along TH 12. Although ***Figure 10*** shows three distinct options, pieces of different options could be combined to produce unique alignments not shown. Different combinations may cause an offset connection at CSAH 34, which is feasible but not recommended. Offset connections increase vehicle conflicts and also can limit turn lane length along CSAH 34 or preclude turn lanes from being built entirely. Option 1 would result in the longest local street connection through utilization of CSAH 34, 260th Street and an extension of Johnson Drive. It is also notable that with Option 1, considerable improvements would be required to 260th street, which is currently in need of widening and repair.

ADDITIONAL CONSIDERATIONS

This section addresses any additional concerns specific to the project location that were not addressed in the evaluation including: terrain issues, pedestrian and/or bicycle issues, and large truck accommodations.

Terrain

The area is relatively flat around the intersection, and sight distances are adequate in all directions. The intersection is slightly skewed with CSAH 34 intersecting TH 12 about 15 degrees from perpendicular. Reconstruction alternatives should consider reducing this skew as much as feasible.

Pedestrian and Bicycle Issues

Pedestrian and bicycle volumes at the intersection of TH 12 and CSAH 34 are low. This intersection and surrounding land uses are not conducive to these types of trips. However, both the traffic signal and roundabout alternatives can be designed to accommodate pedestrian crossings and sidewalk/trail connections.

The City may want to consider the potential to improve pedestrian and bicycle movements with any local road improvements, including the TH 12 frontage road and the extension of Johnson Drive.

Large Truck/Super Load Accommodations

TH 12 is designated as an over-sized/over-weight super load corridor by MnDOT. CSAH 34 is a designated truck bypass route for westbound TH 12 traffic, to avoid downtown Litchfield. Both the traffic signal and roundabout concept alternatives can be designed to accommodate these large vehicles as needed.

SUMMARY AND RECOMMENDATIONS

Table 4 summarizes the results of the analyses presented above and includes recommendations relative to each intersection modification alternative. MnDOT is currently planning to construct an offset right similar to what is built at the intersection of TH 12 and Johnson Drive. Conversion of the existing bypass lane on eastbound TH 12 to a left turn lane should be considered as well. This is largely a safety improvement. Designated turn lanes on CSAH 34 could be striped at this time to allow for right turning vehicles to bypass vehicles waiting to turn left. See **Figure 11** for a depiction of this alternative.

With an initial safety improvement constructed, the focus should shift to further developing and planning for the construction of an improved frontage road/local road system including frontage and/or backage road connections from west of CSAH 34 to the Johnson Drive area. Providing opportunities to make local trips without using TH 12 will shift some traffic away from the TH 12/CSAH 34 intersection, which will allow the intersection to operate at acceptable levels for a longer period of time than without the local road connection. MnDOT, Meeker County, and the City of Litchfield should continue discussions with land owners, and acknowledge that there is potential for future development is a frontage road alignment is ultimately constructed.

Lastly, a long-term traffic control/intersection vision should be determined. The No Build and the Turn Lanes alternatives are not recommended for consideration as the final vision because both alternatives would operate at LOS F (or better) during peak hour 2036. Also, the RCI and the RIRO would operate at LOS D (or better) during 2036 peak hour. Additionally, the RIRO does not meet access and connectivity needs of the area.

MnDOT should continue to monitor the TH 12/CSAH 34 intersection for changes in operations and safety as they relate to a long-term solution. Because thru-stop control with turn lanes is expected to break down as traffic levels increase, a higher level of traffic control or other intersection geometry change is expected to be needed in the future.

Table 4: Intersection Summary Evaluation Matrix

Intersection Modification	Access	Warrant Analysis		Expected Crash Rate*	Intersection LOS (AM/PM)	Max SB CSAH 34 Queue (ft.)	Estimated Construction Cost	Recommendation
		Traffic Signal	Roundabout					
Build Year 2016								
No Build	Full	N/A	N/A	0.80	A/B	123	-	
Add Turn Lanes	Full	N/A	N/A	0.45	A/B	91	$ 525,000.00	
Traffic Signal	Full	Satisfied	Satisfied	0.53	A/B	75	$ 725,000.00	
Roundabout	Full	N/A	N/A	0.22	A/B	25	$ 1,500,000.00	
Green "T"	Full	N/A	N/A	0.40	B/B	106	$ 1,625,000.00	
Reduced Conflict Intersection (RCI)	Partial	N/A	N/A	0.58	C/C	100	$ 2,125,000.00	
Right-in/Right-out (RIRO)	Partial	N/A	N/A	0.30	C/C	87	-	
Design Year 2036								
No Build	Full	N/A	N/A	0.80	C/F	591	-	Eliminate – doesn't address intersection operations
Add Turn Lanes	Full	N/A	N/A	0.45	C/F	418	$ 525,000.00	Eliminate – doesn't address intersection operations
Traffic Signal	Full	Satisfied	Satisfied	0.53	B/B	118	$ 725,000.00	
Roundabout	Full	N/A	N/A	0.22	B/C	50	$ 1,500,000.00	
Green "T"	Full	N/A	N/A	0.40	B/C	158	$ 1,625,000.00	
RCI	Partial	N/A	N/A	0.58	C/D	150	$ 2,125,000.00	Eliminate – higher cost alternative for lesser benefit compared to others
Right-in/Right-out (RIRO)	Partial	N/A	N/A	0.30	C/D	187	-	Eliminate – doesn't meet access/connectivity needs

* Crash Rates calculated based on 2013-2015 data combined with relevant CMF (see Table 1 of this report).

FIGURES

Figure 1: Location Map
Figure 2: Existing (2016) Turning Movement Counts
Figure 3: 2036 Turning Movement Counts
Figure 4: Turn Lanes
Figure 5: Traffic Signal
Figure 6: Roundabout
Figure 7: Green T
Figure 8: R-CUT (Reduced Conflict) Intersection
Figure 9: Frontage Road Options
Figure 10: Short Term Alternative

APPENDIX

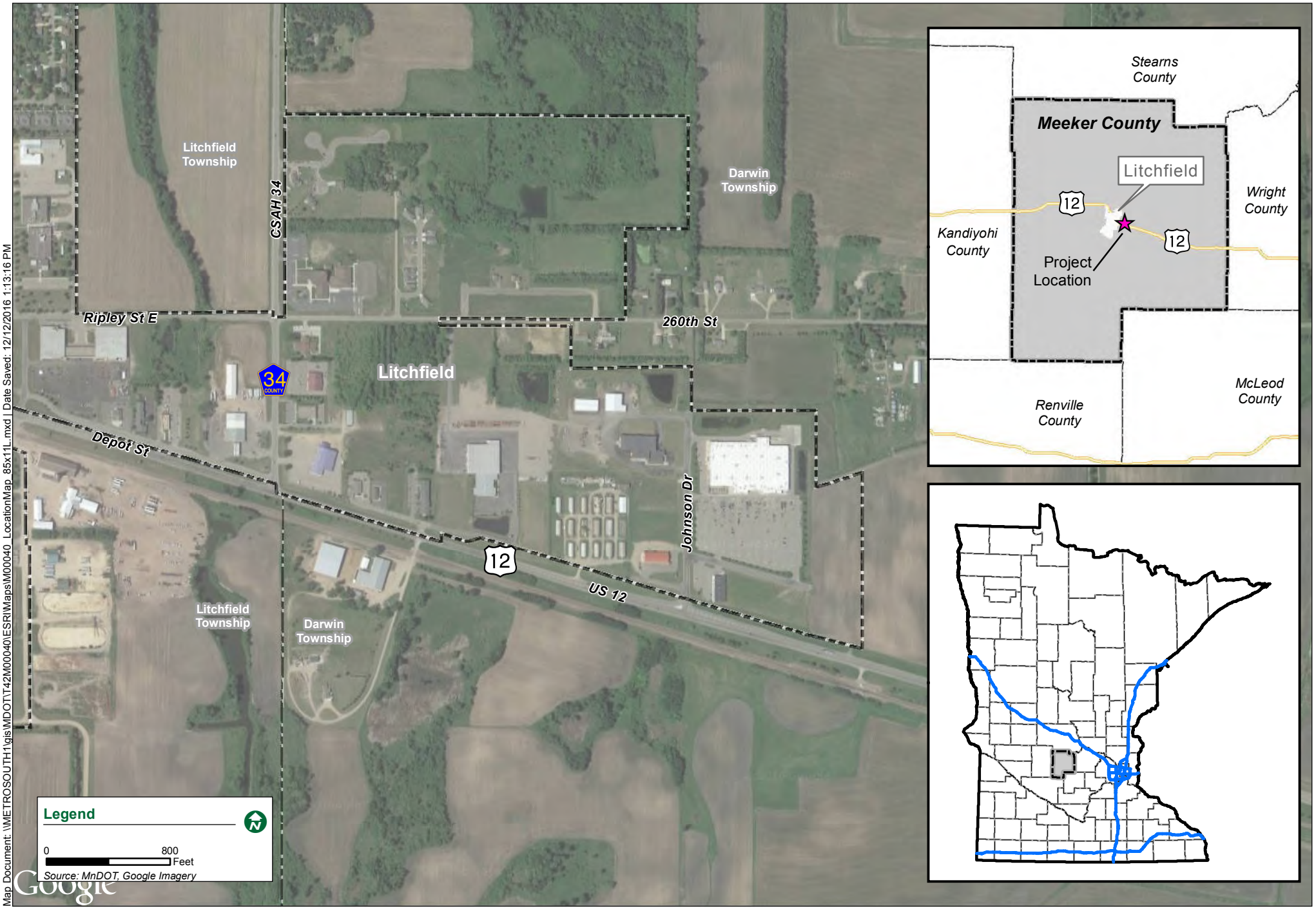
Appendix A: Raw Turning Movement Counts
Appendix B: Traffic Signal Warrant Analyses, 2016 and 2036
Appendix C: Operational Analysis
Appendix D: Crash Analysis

US 12 & CSAH 34 Improvements

MnDOT

Figure 1 - Location Map

December 2016



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US 12 & CSAH 34 Improvements

MnDOT

Figure 2 - Existing (2016) Turning Movement Counts

September 2016

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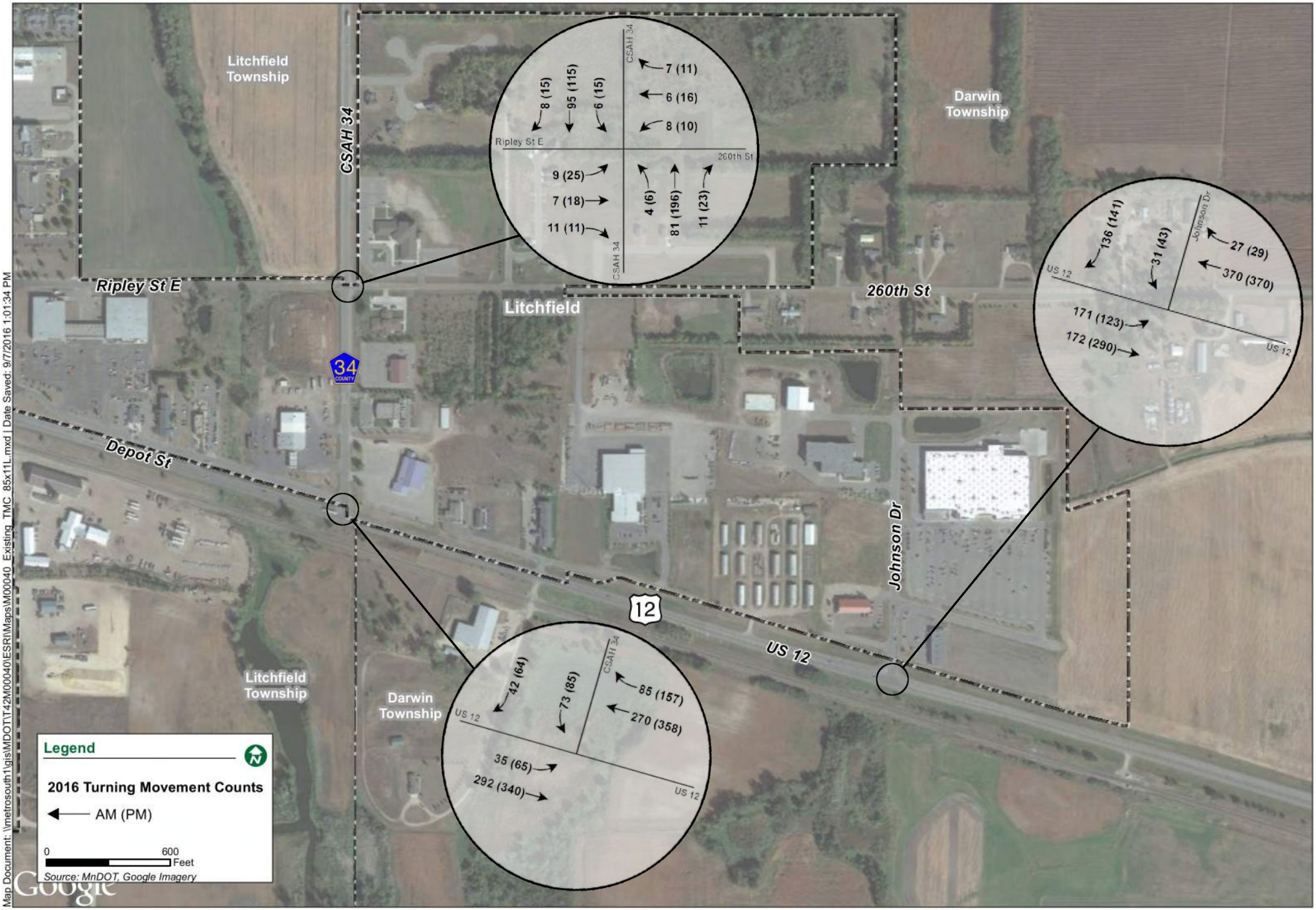
Real People. Real Solutions.



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US 12 & CSAH 34 Improvements

MnDOT

Figure 3 - 2036 Turning Movement Counts

November 2016

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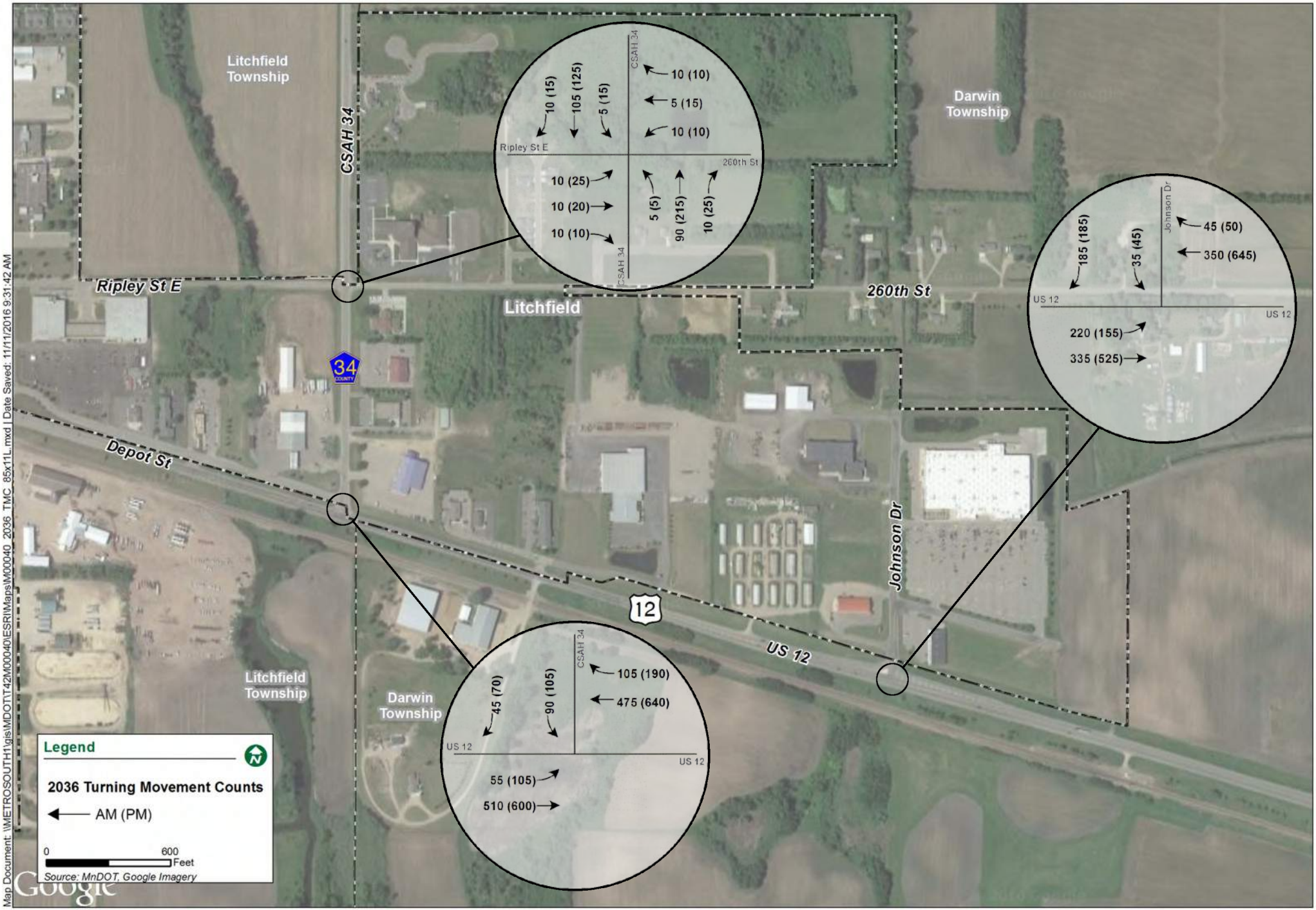

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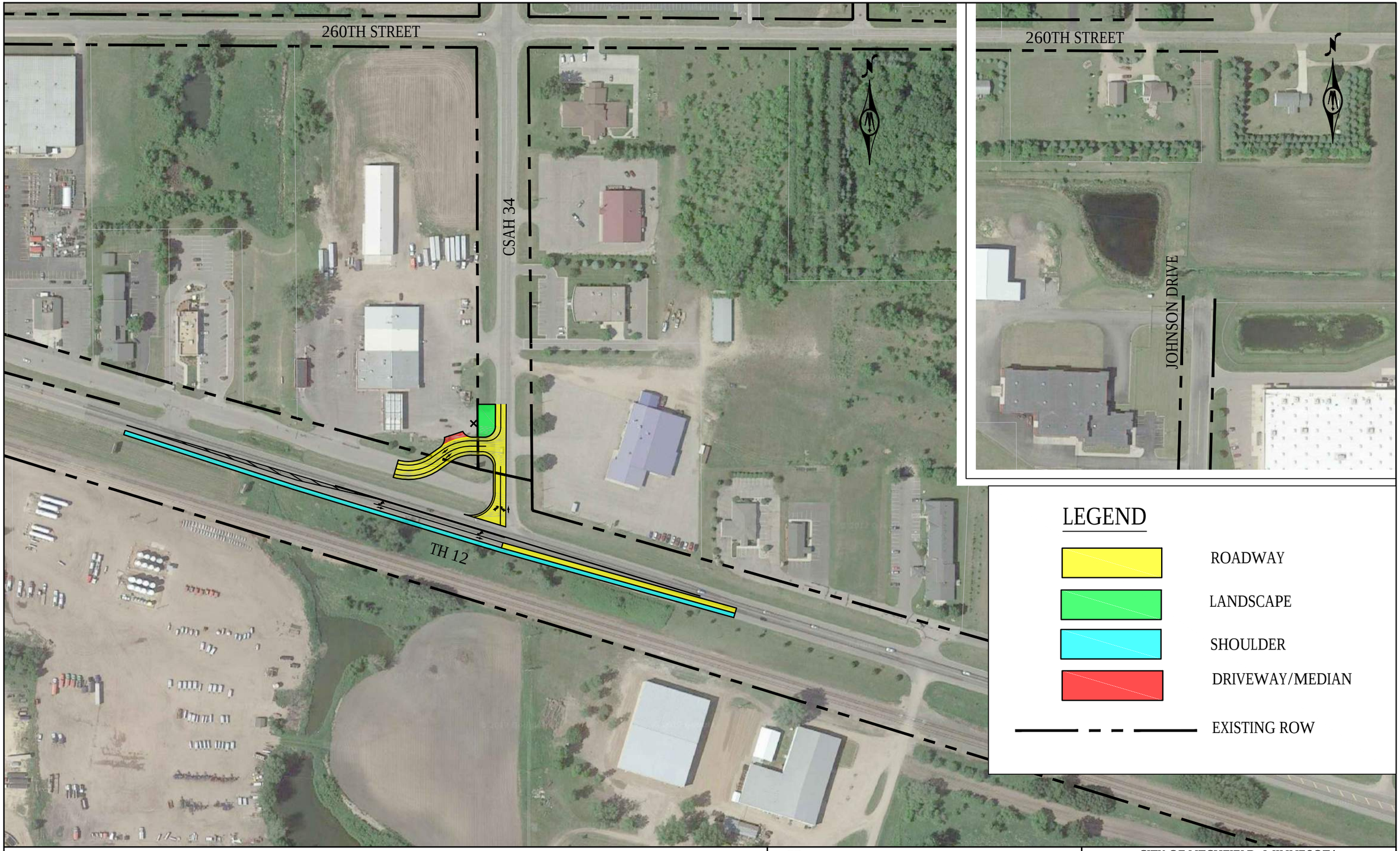

0 100 200
HORZ. SCALE FEET

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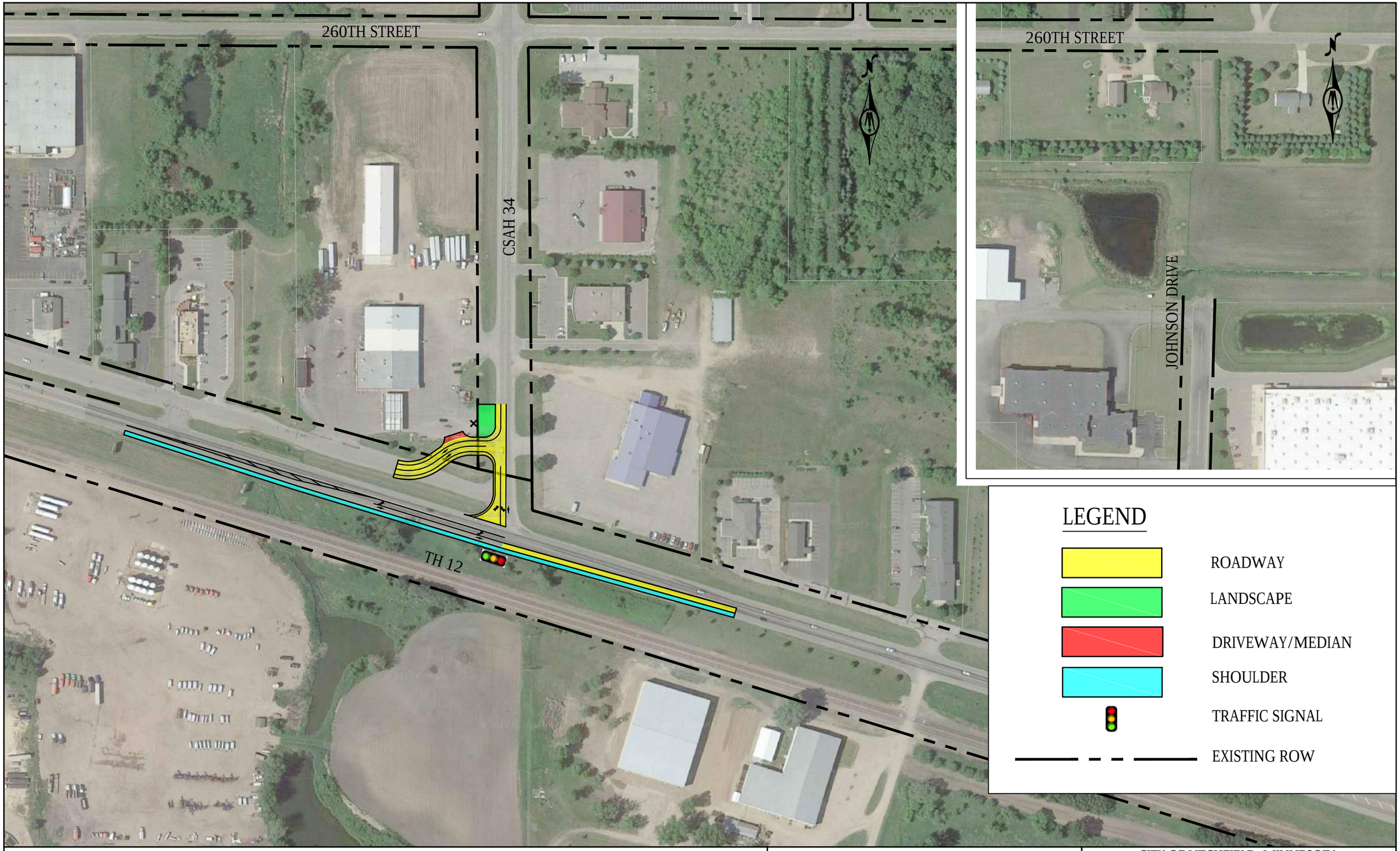
CITY OF LITCHFIELD, MINNESOTA
INTERSECTION STUDY
ADD TURN LANES

MARCH, 2017 FIGURE NO.4



0 100 200
HORZ. SCALE FEET

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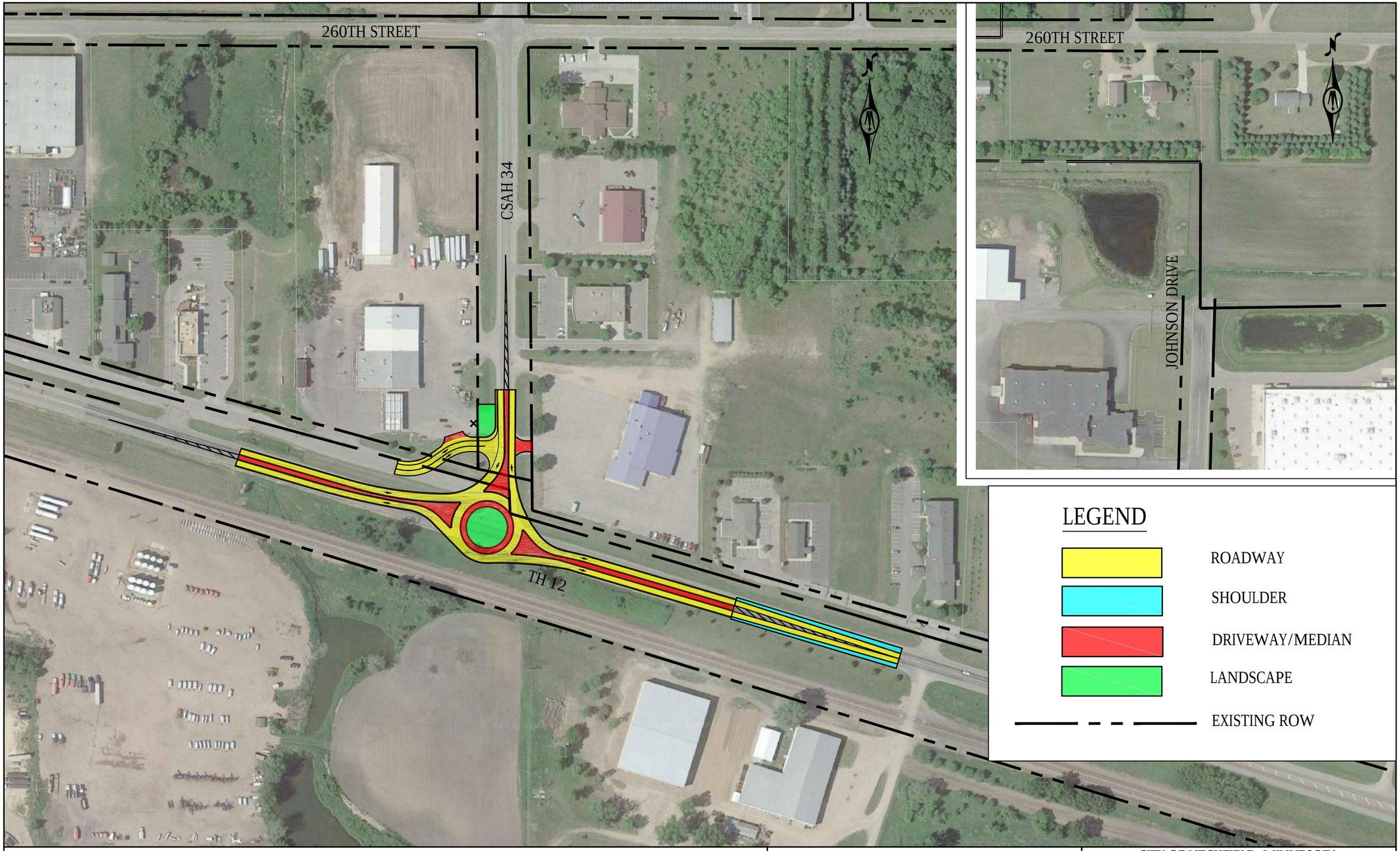
CITY OF LITCHFIELD, MINNESOTA
INTERSECTION STUDY
TRAFFIC SIGNAL

MARCH, 2017 FIGURE NO.5



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HORZ. SCALE FEET

H:\MDOT\T42M00040\CAD\C3D\CSAH 34 at TH 12\00040_BSN_ROUNDABOUT.dwg 3/30/2017 11:49 AM

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CITY OF LITCHFIELD, MINNESOTA
INTERSECTION STUDY
ROUNDABOUT

MARCH, 2017 FIGURE NO.6

260TH STREET

CSAH 34

TH 12

260TH STREET

JOHNSON DRIVE

LEGEND

- ROADWAY
- LANDSCAPE
- SHOULDER
- DRIVEWAY/MEDIAN
- TRAFFIC SIGNAL
- EXISTING ROW

HORZ. SCALE 0 100 200 FEET

H:\MDOT\T42M00040\CAD\C3D\CSAH 34 at TH 12\00040_BSN_GREEN T.dwg 3/30/2017 11:49 AM

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CITY OF LITCHFIELD, MINNESOTA
INTERSECTION STUDY
GREEN T

MARCH, 2017 FIGURE NO.7

LEGEND

- ROADWAY
- LANDSCAPE
- SHOULDER
- DRIVEWAY/MEDIAN
- EXISTING ROW

260TH STREET

CSAH 34

TH 12

260TH STREET

JOHNSON DRIVE

HORZ. SCALE 0 100 200 FEET

H:\MDOT\T42M00040\CAD\C3D\CSAH 34 at TH 12\00040_BSN_RCI.dwg 3/30/2017 11:50 AM

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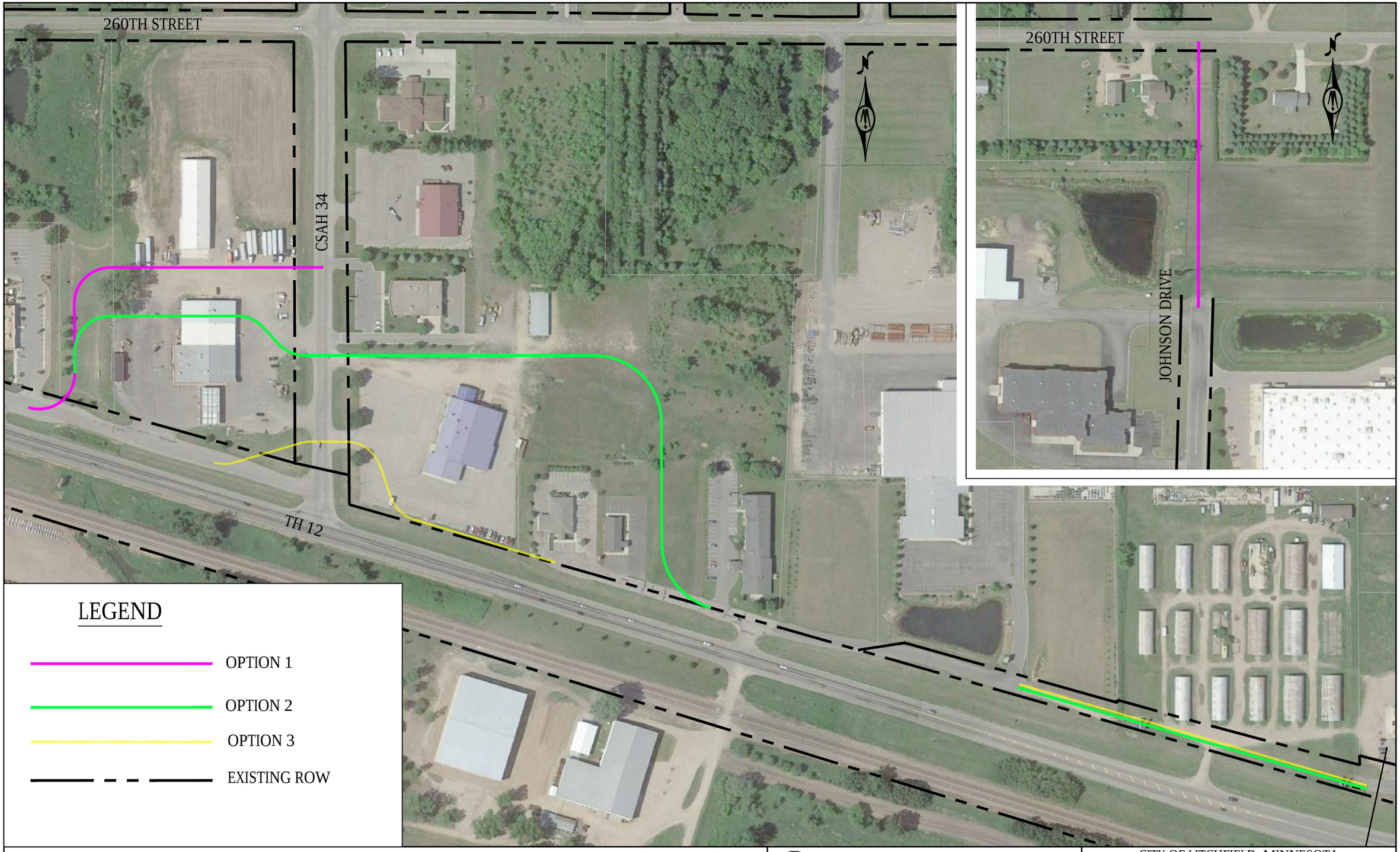
CITY OF LITCHFIELD, MINNESOTA

INTERSECTION STUDY

R-CUT INTERSECTION

MARCH, 2017

FIGURE NO.8



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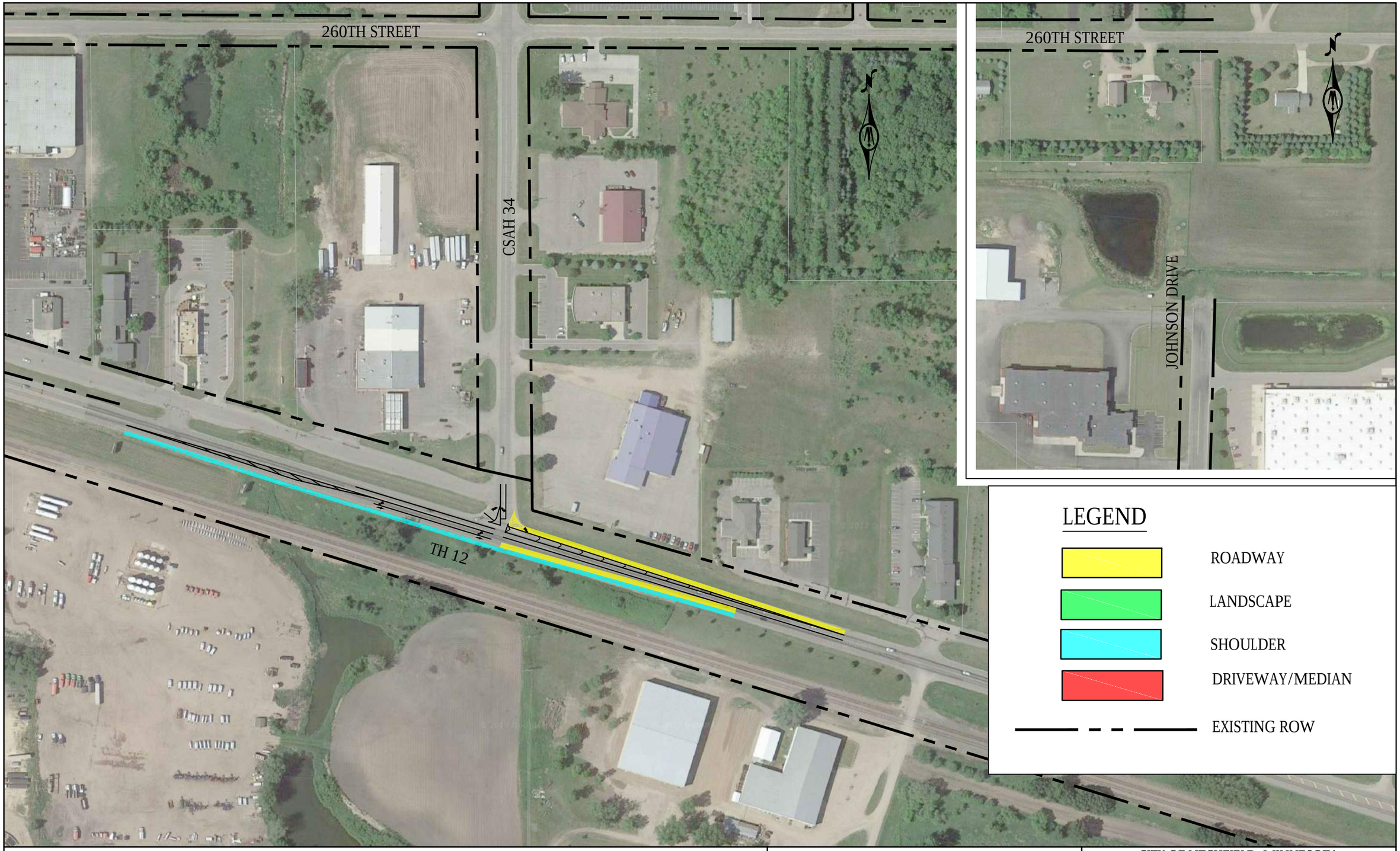
CITY OF LITCHFIELD, MINNESOTA
INTERSECTION STUDY
FRONTAGE ROAD OPTIONS

MARCH, 2017 FIGURE NO.9



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HORZ. SCALE FEET

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CITY OF LITCHFIELD, MINNESOTA
INTERSECTION STUDY
SHORT TERM ALTERNATIVE

MARCH, 2017 FIGURE NO.10

APPENDIX A

Raw Turning Movement Counts

Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : TH 12 and Johnson Drive
Site Code : 1
Start Date : 8/9/2016
Page No : 1

TH 12 at Johnson Drive
Litchfield, MN

Groups Printed- Cars + - Trucks

	Johnson Drive Southbound				TH 12 Westbound				TH 12 Eastbound				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
06:00 AM	2	3	0	5	1	12	0	13	24	8	0	32	50
06:15 AM	3	2	0	5	6	31	0	37	51	17	0	68	110
06:30 AM	12	2	0	14	5	41	0	46	53	16	0	69	129
06:45 AM	7	9	0	16	6	31	0	37	39	15	0	54	107
Total	24	16	0	40	18	115	0	133	167	56	0	223	396
07:00 AM	1	3	0	4	6	32	0	38	35	24	0	59	101
07:15 AM	20	4	0	24	5	35	0	40	31	15	0	46	110
07:30 AM	18	2	0	20	7	50	0	57	50	11	0	61	138
07:45 AM	12	2	0	14	1	45	0	46	53	15	0	68	128
Total	51	11	0	62	19	162	0	181	169	65	0	234	477
08:00 AM	16	2	0	18	1	58	0	59	36	19	0	55	132
08:15 AM	17	1	0	18	2	37	0	39	39	21	0	60	117
08:30 AM	15	2	0	17	5	46	0	51	42	14	0	56	124
08:45 AM	16	2	0	18	6	43	0	49	33	13	0	46	113
Total	64	7	0	71	14	184	0	198	150	67	0	217	486
09:00 AM	18	2	0	20	3	32	0	35	44	29	0	73	128
09:15 AM	18	2	0	20	3	40	0	43	64	34	0	98	161
09:30 AM	21	5	0	26	7	52	0	59	35	33	0	68	153
09:45 AM	21	7	0	28	7	57	0	64	38	30	0	68	160
Total	78	16	0	94	20	181	0	201	181	126	0	307	602
10:00 AM	25	5	0	30	5	34	0	39	40	41	0	81	150
10:15 AM	38	8	0	46	7	47	0	54	52	33	0	85	185
10:30 AM	34	4	0	38	6	44	0	50	42	32	0	74	162
10:45 AM	30	6	0	36	8	44	0	52	47	48	0	95	183
Total	127	23	0	150	26	169	0	195	181	154	0	335	680
11:00 AM	35	7	0	42	5	48	0	53	37	45	0	82	177
11:15 AM	29	9	0	38	6	47	0	53	40	37	0	77	168
11:30 AM	42	9	0	51	8	49	0	57	48	41	0	89	197
11:45 AM	48	9	0	57	10	49	0	59	51	56	0	107	223
Total	154	34	0	188	29	193	0	222	176	179	0	355	765
12:00 PM	60	7	0	67	11	34	0	45	45	52	0	97	209
12:15 PM	39	17	0	56	4	45	0	49	49	39	0	88	193
12:30 PM	41	7	0	48	7	44	0	51	48	37	0	85	184
12:45 PM	31	9	0	40	5	56	0	61	51	42	0	93	194
Total	171	40	0	211	27	179	0	206	193	170	0	363	780
01:00 PM	39	4	0	43	10	52	0	62	54	33	0	87	192

Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : TH 12 and Johnson Drive
Site Code : 1
Start Date : 8/9/2016

Groups Printed- Cars + - Trucks

	Johnson Drive Southbound				TH 12 Westbound				TH 12 Eastbound				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
01:15 PM	42	11	0	53	4	54	0	58	54	46	0	100	211
01:30 PM	38	5	0	43	10	51	0	61	57	46	0	103	207
01:45 PM	25	5	0	30	3	22	0	25	26	27	0	53	108
Total	144	25	0	169	27	179	0	206	191	152	0	343	718
02:00 PM	45	8	0	53	6	50	0	56	64	49	0	113	222
02:15 PM	43	11	0	54	7	53	0	60	54	32	0	86	200
02:30 PM	41	11	0	52	6	56	0	62	65	35	0	100	214
02:45 PM	35	10	0	45	3	56	0	59	59	42	0	101	205
Total	164	40	0	204	22	215	0	237	242	158	0	400	841
03:00 PM	37	12	0	49	4	43	0	47	60	43	0	103	199
03:15 PM	43	8	0	51	10	58	0	68	55	40	0	95	214
03:30 PM	42	7	0	49	4	75	0	79	62	43	0	105	233
03:45 PM	44	10	0	54	7	77	0	84	64	53	0	117	255
Total	166	37	0	203	25	253	0	278	241	179	0	420	901
04:00 PM	53	12	0	65	13	57	0	70	59	37	0	96	231
04:15 PM	43	8	0	51	6	54	0	60	72	44	0	116	227
04:30 PM	45	7	0	52	13	58	0	71	69	51	0	120	243
04:45 PM	34	13	0	47	8	66	0	74	63	41	0	104	225
Total	175	40	0	215	40	235	0	275	263	173	0	436	926
05:00 PM	54	17	0	71	5	50	0	55	46	35	0	81	207
05:15 PM	38	11	0	49	10	56	0	66	80	48	0	128	243
05:30 PM	33	12	0	45	7	55	0	62	37	25	0	62	169
05:45 PM	16	3	0	19	7	24	0	31	30	15	0	45	95
Total	141	43	0	184	29	185	0	214	193	123	0	316	714
06:00 PM	36	10	0	46	7	59	0	66	53	38	0	91	203
06:15 PM	44	10	0	54	2	37	0	39	32	29	0	61	154
06:30 PM	27	10	0	37	8	49	0	57	35	28	0	63	157
06:45 PM	34	3	0	37	9	40	0	49	28	29	0	57	143
Total	141	33	0	174	26	185	0	211	148	124	0	272	657
07:00 PM	6	1	0	7	5	15	0	20	3	7	0	10	37
Grand Total	1606	366	0	1972	327	2450	0	2777	2498	1733	0	4231	8980
Apprch %	81.4	18.6	0		11.8	88.2	0		59	41	0		
Total %	17.9	4.1	0	22	3.6	27.3	0	30.9	27.8	19.3	0	47.1	
Cars +	1606	365	0	1971	327	2450	0	2777	2498	1733	0	4231	8979
% Cars +	100	99.7	0	99.9	100	100	0	100	100	100	0	100	100
Trucks	0	1	0	1	0	0	0	0	0	0	0	0	1
% Trucks	0	0.3	0	0.1	0	0	0	0	0	0	0	0	0

Bolton & Menk, Inc.

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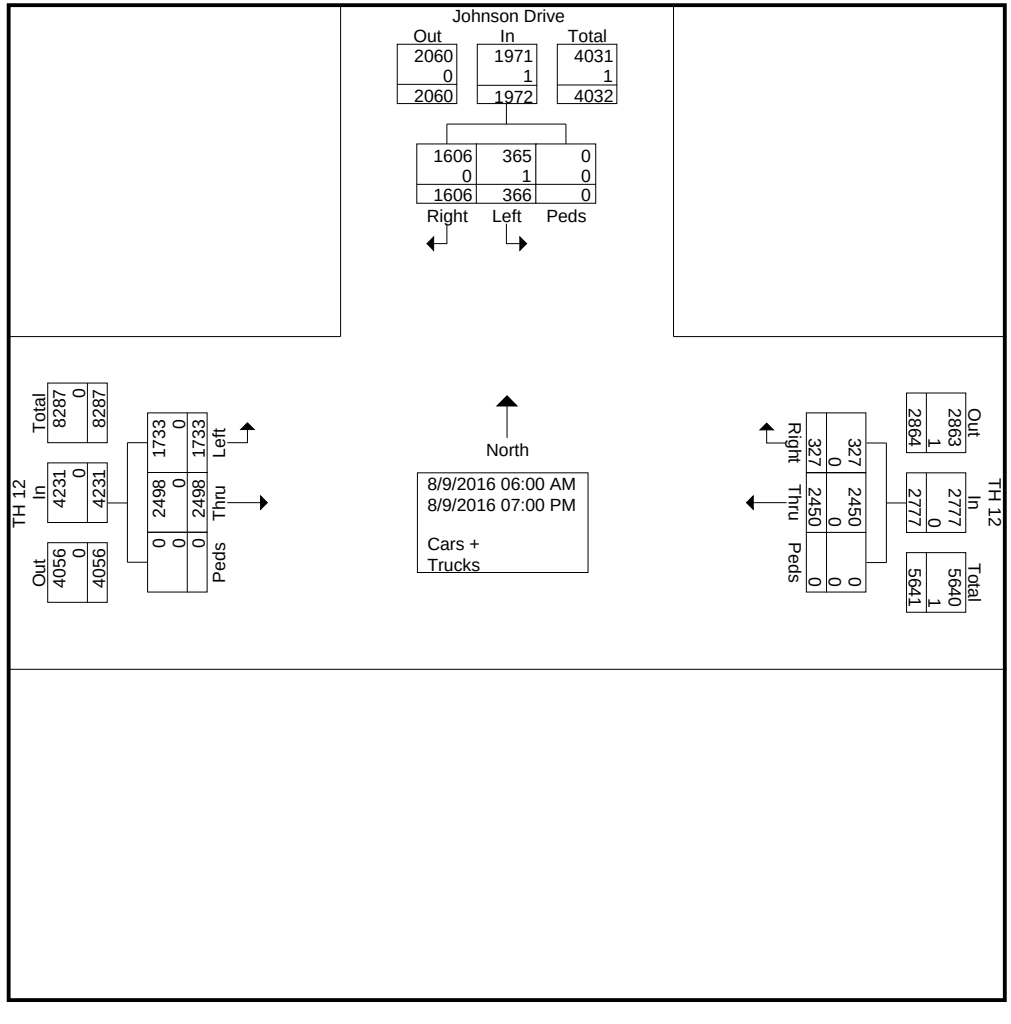
Burnsville, MN, 55337

File Name : TH 12 and Johnson Drive
Site Code : 1
Start Date : 8/9/2016
Page No : 3



Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : TH 12 and Johnson Drive
Site Code : 1
Start Date : 8/9/2016
Page No : 4

	Johnson Drive Southbound				TH 12 Westbound				TH 12 Eastbound				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 11:45 AM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 11:00 AM													
11:00 AM	35	7	0	42	5	48	0	53	37	45	0	82	177
11:15 AM	29	**9**	0	38	6	47	0	53	40	37	0	77	168
11:30 AM	42	9	0	51	8	**49**	0	57	48	41	0	89	197
11:45 AM	**48**	9	0	**57**	**10**	49	0	**59**	**51**	**56**	0	**107**	**223**
Total Volume	154	34	0	188	29	193	0	222	176	179	0	355	765
% App. Total	81.9	18.1	0		13.1	86.9	0		49.6	50.4	0		
PHF	.802	.944	.000	.825	.725	.985	.000	.941	.863	.799	.000	.829	.858
Peak Hour Analysis From 12:00 PM to 07:00 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 03:45 PM													
03:45 PM	44	10	0	54	7	**77**	0	**84**	64	**53**	0	117	**255**
04:00 PM	**53**	**12**	0	**65**	**13**	57	0	70	59	37	0	96	231
04:15 PM	43	8	0	51	6	54	0	60	**72**	44	0	116	227
04:30 PM	45	7	0	52	13	58	0	71	69	51	0	**120**	243
Total Volume	185	37	0	222	39	246	0	285	264	185	0	449	956
% App. Total	83.3	16.7	0		13.7	86.3	0		58.8	41.2	0		
PHF	.873	.771	.000	.854	.750	.799	.000	.848	.917	.873	.000	.935	.937

Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : TH 12 and CSAH 34
Site Code : 2
Start Date : 7/27/2016
Page No : 1

TH 12 at CSAH 34
Litchfield, MN

Groups Printed- Cars + - Trucks

	CSAH 34 Southbound				TH 12 Westbound				TH 12 Eastbound				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
06:00 AM	0	7	0	7	3	15	0	18	41	5	0	46	71
06:15 AM	6	12	0	18	13	24	0	37	56	3	0	59	114
06:30 AM	7	8	0	15	8	21	0	29	45	7	0	52	96
06:45 AM	8	17	0	25	18	31	0	49	40	8	0	48	122
Total	21	44	0	65	42	91	0	133	182	23	0	205	403
07:00 AM	8	21	0	29	13	36	0	49	42	5	0	47	125
07:15 AM	7	20	0	27	18	46	0	64	45	4	0	49	140
07:30 AM	10	11	0	21	14	46	0	60	49	4	0	53	134
07:45 AM	13	18	0	31	22	60	0	82	64	13	0	77	190
Total	38	70	0	108	67	188	0	255	200	26	0	226	589
08:00 AM	6	15	0	21	19	37	0	56	51	13	0	64	141
08:15 AM	14	19	0	33	5	50	0	55	41	7	0	48	136
08:30 AM	7	25	0	32	13	39	0	52	50	9	0	59	143
08:45 AM	13	15	0	28	15	54	0	69	45	7	0	52	149
Total	40	74	0	114	52	180	0	232	187	36	0	223	569
09:00 AM	7	13	0	20	13	47	0	60	48	8	0	56	136
09:15 AM	16	13	0	29	11	51	0	62	58	10	0	68	159
09:30 AM	8	20	0	28	18	53	0	71	60	6	0	66	165
09:45 AM	10	20	0	30	14	75	0	89	66	12	0	78	197
Total	41	66	0	107	56	226	0	282	232	36	0	268	657
10:00 AM	13	8	0	21	13	48	0	61	59	5	0	64	146
10:15 AM	7	20	0	27	16	64	0	80	67	13	0	80	187
10:30 AM	6	8	0	14	21	69	0	90	91	9	0	100	204
10:45 AM	8	15	0	23	26	73	0	99	75	8	0	83	205
Total	34	51	0	85	76	254	0	330	292	35	0	327	742
11:00 AM	12	19	0	31	15	76	0	91	68	7	0	75	197
11:15 AM	11	22	0	33	19	51	0	70	65	12	0	77	180
11:30 AM	11	17	0	28	25	70	0	95	84	8	0	92	215
11:45 AM	12	13	0	25	27	66	0	93	72	7	0	79	197
Total	46	71	0	117	86	263	0	349	289	34	0	323	789
12:00 PM	9	17	0	26	22	64	0	86	87	11	0	98	210
12:15 PM	16	26	0	42	16	86	0	102	58	13	0	71	215
12:30 PM	5	11	0	16	24	52	0	76	78	8	0	86	178
12:45 PM	7	17	0	24	17	56	0	73	108	8	0	116	213
Total	37	71	0	108	79	258	0	337	331	40	0	371	816
01:00 PM	11	15	0	26	21	72	0	93	80	14	0	94	213

Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : TH 12 and CSAH 34
Site Code : 2
Start Date : 7/27/2016
Page No : 2

Groups Printed- Cars + - Trucks

	CSAH 34 Southbound				TH 12 Westbound				TH 12 Eastbound				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
01:15 PM	12	22	0	34	25	78	0	103	70	15	0	85	222
01:30 PM	13	18	0	31	33	75	0	108	70	11	0	81	220
01:45 PM	10	22	0	32	27	62	0	89	69	10	0	79	200
Total	46	77	0	123	106	287	0	393	289	50	0	339	855
02:00 PM	9	23	0	32	22	75	0	97	83	9	0	92	221
02:15 PM	5	29	0	34	27	82	0	109	63	7	0	70	213
02:30 PM	8	16	0	24	26	81	0	107	80	11	0	91	222
02:45 PM	8	20	0	28	30	83	0	113	90	13	0	103	244
Total	30	88	0	118	105	321	0	426	316	40	0	356	900
03:00 PM	11	21	0	32	29	81	0	110	81	12	0	93	235
03:15 PM	11	20	0	31	30	60	0	90	89	8	0	97	218
03:30 PM	10	24	0	34	33	87	0	120	82	11	0	93	247
03:45 PM	11	17	0	28	35	86	0	121	69	21	0	90	239
Total	43	82	0	125	127	314	0	441	321	52	0	373	939
04:00 PM	9	22	0	31	40	82	0	122	83	9	0	92	245
04:15 PM	11	23	0	34	38	74	0	112	87	8	0	95	241
04:30 PM	20	23	0	43	36	92	0	128	93	28	0	121	292
04:45 PM	9	7	0	16	19	37	0	56	29	7	0	36	108
Total	49	75	0	124	133	285	0	418	292	52	0	344	886
05:00 PM	20	32	0	52	50	96	0	146	86	21	0	107	305
05:15 PM	8	14	0	22	37	88	0	125	100	19	0	119	266
05:30 PM	11	18	0	29	31	89	0	120	69	14	0	83	232
05:45 PM	25	21	0	46	39	85	0	124	85	11	0	96	266
Total	64	85	0	149	157	358	0	515	340	65	0	405	1069
06:00 PM	10	23	0	33	20	65	0	85	62	15	0	77	195
06:15 PM	14	19	0	33	21	61	0	82	58	9	0	67	182
06:30 PM	6	20	0	26	33	58	0	91	59	9	0	68	185
06:45 PM	5	16	0	21	23	55	0	78	48	9	0	57	156
Total	35	78	0	113	97	239	0	336	227	42	0	269	718
07:00 PM	3	15	0	18	15	27	0	42	39	5	0	44	104
Grand Total	527	947	0	1474	1198	3291	0	4489	3537	536	0	4073	10036
Apprch %	35.8	64.2	0		26.7	73.3	0		86.8	13.2	0		
Total %	5.3	9.4	0	14.7	11.9	32.8	0	44.7	35.2	5.3	0	40.6	
Cars +	527	947	0	1474	1198	3291	0	4489	3537	536	0	4073	10036
% Cars +	100	100	0	100	100	100	0	100	100	100	0	100	100
Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0
% Trucks	0	0	0	0	0	0	0	0	0	0	0	0	0

Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : TH 12 and CSAH 34
Site Code : 2
Start Date : 7/27/2016
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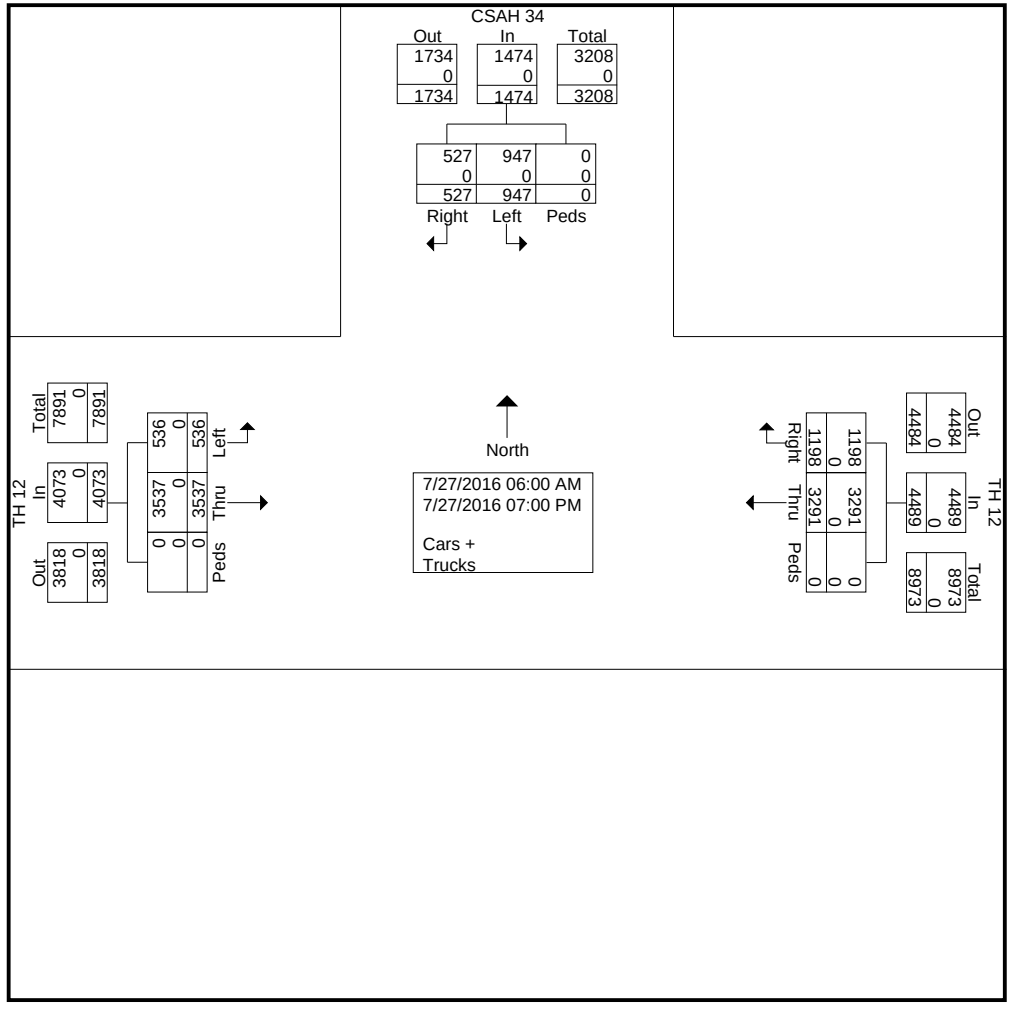


Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : TH 12 and CSAH 34
Site Code : 2
Start Date : 7/27/2016
Page No : 4

	CSAH 34 Southbound				TH 12 Westbound				TH 12 Eastbound				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 11:45 AM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 10:45 AM													
10:45 AM	8	15	0	23	**26**	73	0	**99**	75	8	0	83	205
11:00 AM	**12**	19	0	31	15	**76**	0	91	68	7	0	75	197
11:15 AM	11	**22**	0	**33**	19	51	0	70	65	**12**	0	77	180
11:30 AM	11	17	0	28	25	70	0	95	**84**	8	0	**92**	**215**
Total Volume	42	73	0	115	85	270	0	355	292	35	0	327	797
% App. Total	36.5	63.5	0		23.9	76.1	0		89.3	10.7	0		
PHF	.875	.830	.000	.871	.817	.888	.000	.896	.869	.729	.000	.889	.927
Peak Hour Analysis From 12:00 PM to 07:00 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 05:00 PM													
05:00 PM	20	**32**	0	**52**	**50**	**96**	0	**146**	86	**21**	0	107	**305**
05:15 PM	8	14	0	22	37	88	0	125	**100**	19	0	**119**	266
05:30 PM	11	18	0	29	31	89	0	120	69	14	0	83	232
05:45 PM	**25**	21	0	46	39	85	0	124	85	11	0	96	266
Total Volume	64	85	0	149	157	358	0	515	340	65	0	405	1069
% App. Total	43	57	0		30.5	69.5	0		84	16	0		
PHF	.640	.664	.000	.716	.785	.932	.000	.882	.850	.774	.000	.851	.876

Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : CSAH 34 at 260th Street
Site Code : 3
Start Date : 7/28/2016
Page No : 1

CSAH 34 at 260th Street
Litchfield, MN

Groups Printed- Cars+ - Trucks

	CSAH 34 Southbound					260th Street Westbound					CSAH 34 Northbound					260th Street Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
06:00 AM	0	7	0	0	7	0	0	1	0	1	1	7	0	0	8	0	1	1	0	2	18
06:15 AM	4	18	0	0	22	0	1	1	0	2	2	13	0	0	15	0	0	1	0	1	40
06:30 AM	1	11	1	0	13	0	3	0	0	3	0	10	1	0	11	0	1	3	0	4	31
06:45 AM	5	20	2	0	27	2	3	1	0	6	0	17	2	0	19	1	3	2	0	6	58
Total	10	56	3	0	69	2	7	3	0	12	3	47	3	0	53	1	5	7	0	13	147
07:00 AM	1	32	0	0	33	3	1	2	0	6	2	11	0	0	13	1	4	4	0	9	61
07:15 AM	2	25	0	0	27	1	3	1	0	5	2	22	3	0	27	0	0	2	0	2	61
07:30 AM	0	27	2	0	29	2	4	3	0	9	2	13	0	0	15	1	1	0	0	2	55
07:45 AM	4	28	3	0	35	2	4	8	0	14	5	24	2	0	31	1	5	1	0	7	87
Total	7	112	5	0	124	8	12	14	0	34	11	70	5	0	86	3	10	7	0	20	264
08:00 AM	1	25	4	0	30	2	2	4	0	8	6	24	1	0	31	1	3	4	0	8	77
08:15 AM	2	21	2	0	25	4	1	3	0	8	4	13	0	0	17	0	1	0	0	1	51
08:30 AM	1	23	3	0	27	2	2	4	0	8	3	20	2	0	25	5	0	2	0	7	67
08:45 AM	1	32	4	0	37	3	5	4	0	12	1	29	1	0	31	0	0	1	0	1	81
Total	5	101	13	0	119	11	10	15	0	36	14	86	4	0	104	6	4	7	0	17	276
09:00 AM	4	24	1	0	29	1	2	1	0	4	1	18	1	0	20	3	3	4	0	10	63
09:15 AM	3	26	0	0	29	5	3	2	0	10	1	17	0	0	18	0	2	5	0	7	64
09:30 AM	2	22	5	0	29	0	1	1	0	2	3	16	1	0	20	1	1	2	0	4	55
09:45 AM	1	28	2	0	31	4	0	2	0	6	6	24	2	0	32	2	2	5	0	9	78
Total	10	100	8	0	118	10	6	6	0	22	11	75	4	0	90	6	8	16	0	30	260
10:00 AM	1	17	0	0	18	1	1	3	0	5	3	23	1	0	27	2	0	1	0	3	53
10:15 AM	2	18	3	0	23	3	5	7	0	15	3	23	1	0	27	3	2	3	0	8	73
10:30 AM	4	14	1	0	19	3	3	0	0	6	3	21	1	0	25	0	0	7	0	7	57
10:45 AM	2	24	1	0	27	3	0	1	0	4	3	26	0	0	29	0	1	2	0	3	63
Total	9	73	5	0	87	10	9	11	0	30	12	93	3	0	108	5	3	13	0	21	246
11:00 AM	0	18	2	0	20	1	1	1	0	3	2	21	0	0	23	4	2	2	0	8	54
11:15 AM	3	23	0	0	26	1	4	3	0	8	2	18	2	0	22	4	2	4	0	10	66
11:30 AM	3	30	3	0	36	2	1	3	0	6	4	16	2	0	22	3	2	1	0	6	70
11:45 AM	1	26	4	0	31	2	2	5	0	9	5	29	2	0	36	1	2	3	0	6	82
Total	7	97	9	0	113	6	8	12	0	26	13	84	6	0	103	12	8	10	0	30	272
12:00 PM	3	21	2	0	26	6	3	3	0	12	3	31	0	0	34	2	0	2	0	4	76
12:15 PM	3	33	0	0	36	3	2	3	0	8	6	31	1	0	38	4	4	4	0	12	94
12:30 PM	2	13	2	0	17	2	1	1	0	4	0	22	3	0	25	4	4	4	0	12	58
12:45 PM	3	22	2	0	27	2	1	1	0	4	1	22	2	0	25	5	6	7	0	18	74
Total	11	89	6	0	106	13	7	8	0	28	10	106	6	0	122	15	14	17	0	46	302

Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : CSAH 34 at 260th Street
Site Code : 3
Start Date : 7/28/2016
Page No : 2

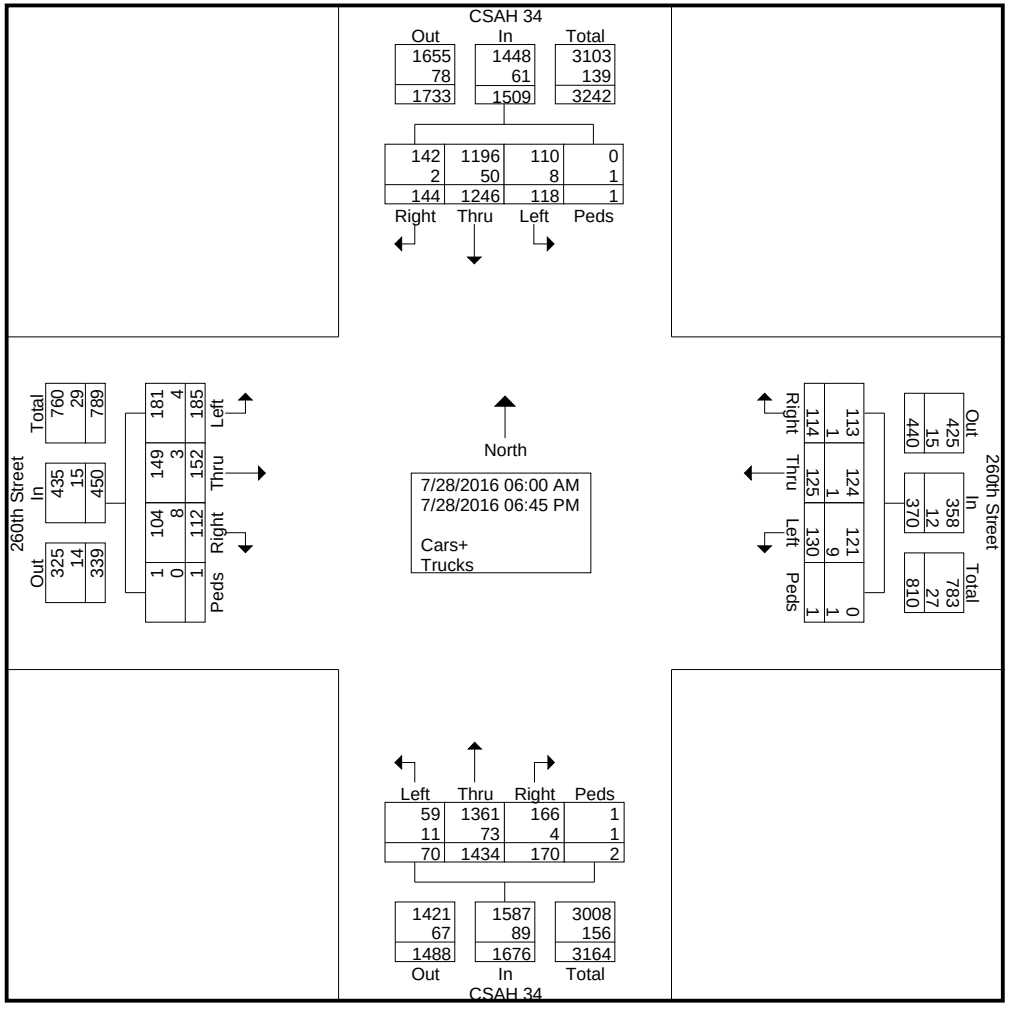
CSAH 34 at 260th Street
Litchfield, MN

Groups Printed- Cars+ - Trucks

	CSAH 34 Southbound					260th Street Westbound					CSAH 34 Northbound					260th Street Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
01:00 PM	3	20	1	0	24	0	0	3	0	3	5	26	3	0	34	1	2	2	0	5	66
01:15 PM	7	30	1	0	38	1	6	3	0	10	4	27	0	0	31	2	4	1	0	7	86
01:30 PM	2	19	1	0	22	1	2	2	0	5	2	36	2	0	40	1	2	0	0	3	70
01:45 PM	0	20	1	0	21	1	6	1	0	8	1	33	0	0	34	4	5	4	0	13	76
Total	12	89	4	0	105	3	14	9	0	26	12	122	5	0	139	8	13	7	0	28	298
02:00 PM	4	30	1	0	35	4	2	3	0	9	1	30	0	0	31	3	2	5	0	10	85
02:15 PM	5	19	5	0	29	0	1	2	0	3	3	25	1	0	29	5	1	4	0	10	71
02:30 PM	5	21	4	0	30	2	1	2	0	5	2	36	1	0	39	3	3	7	0	13	87
02:45 PM	3	23	1	0	27	4	5	3	0	12	3	29	4	0	36	5	3	2	0	10	85
Total	17	93	11	0	121	10	9	10	0	29	9	120	6	0	135	16	9	18	0	43	328
03:00 PM	0	21	4	0	25	0	1	4	0	5	7	31	1	0	39	3	6	7	0	16	85
03:15 PM	6	27	2	0	35	0	3	2	0	5	6	31	2	0	39	3	4	6	0	13	92
03:30 PM	1	25	2	0	28	3	5	3	0	11	2	28	2	0	32	6	2	10	0	18	89
03:45 PM	5	19	6	0	30	2	2	4	0	8	3	38	1	0	42	4	2	1	0	7	87
Total	12	92	14	0	118	5	11	13	0	29	18	128	6	0	152	16	14	24	0	54	353
04:00 PM	3	25	6	0	34	4	2	2	0	8	6	44	3	0	53	1	7	5	0	13	108
04:15 PM	0	31	4	0	35	1	1	3	0	5	2	38	0	0	40	1	4	0	0	5	85
04:30 PM	5	37	2	0	44	2	1	4	0	7	5	48	4	0	57	4	11	5	0	20	128
04:45 PM	7	51	0	0	58	2	7	1	0	10	2	53	1	0	56	2	5	7	0	14	138
Total	15	144	12	0	171	9	11	10	0	30	15	183	8	0	206	8	27	17	0	52	459
05:00 PM	3	30	4	0	37	0	5	2	1	8	5	61	1	0	67	3	4	7	0	14	126
05:15 PM	6	23	9	0	38	3	2	2	0	7	8	49	3	0	60	5	4	7	0	16	121
05:30 PM	3	32	1	1	37	5	4	2	0	11	6	45	1	0	52	2	7	5	0	14	114
05:45 PM	3	30	1	0	34	3	5	4	0	12	4	41	1	0	46	1	3	6	0	10	102
Total	15	115	15	1	146	11	16	10	1	38	23	196	6	0	225	11	18	25	0	54	463
06:00 PM	6	20	2	0	28	4	1	2	0	7	6	30	3	1	40	2	8	4	0	14	89
06:15 PM	4	23	5	0	32	5	3	1	0	9	5	28	1	0	34	2	3	2	0	7	82
06:30 PM	2	23	5	0	30	4	0	5	0	9	5	36	3	1	45	1	5	7	1	14	98
06:45 PM	2	19	1	0	22	3	1	1	0	5	3	30	1	0	34	0	3	4	0	7	68
Total	14	85	13	0	112	16	5	9	0	30	19	124	8	2	153	5	19	17	1	42	337
Grand Total	144	1246	118	1	1509	114	125	130	1	370	170	1434	70	2	1676	112	152	185	1	450	4005
Apprch %	9.5	82.6	7.8	0.1		30.8	33.8	35.1	0.3		10.1	85.6	4.2	0.1		24.9	33.8	41.1	0.2		
Total %	3.6	31.1	2.9	0	37.7	2.8	3.1	3.2	0	9.2	4.2	35.8	1.7	0	41.8	2.8	3.8	4.6	0	11.2	
Cars+	142	1196	110	0	1448	113	124	121	0	358	166	1361	59	1	1587	104	149	181	1	435	3828
% Cars+	98.6	96	93.2	0	96	99.1	99.2	93.1	0	96.8	97.6	94.9	84.3	50	94.7	92.9	98	97.8	100	96.7	95.6
Trucks	2	50	8	1	61	1	1	9	1	12	4	73	11	1	89	8	3	4	0	15	177
% Trucks	1.4	4	6.8	100	4	0.9	0.8	6.9	100	3.2	2.4	5.1	15.7	50	5.3	7.1	2	2.2	0	3.3	4.4

Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337



Bolton & Menk, Inc.

12224 Nicollet Ave
Burnsville, MN, 55337

File Name : CSAH 34 at 260th Street
Site Code : 3
Start Date : 7/28/2016
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CSAH 34 at 260th Street
Litchfield, MN

	CSAH 34 Southbound					260th Street Westbound					CSAH 34 Northbound					260th Street Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:00 AM to 11:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:45 AM																					
07:45 AM	**4**	**28**	3	0	**35**	2	**4**	**8**	0	**14**	5	**24**	**2**	0	**31**	1	**5**	1	0	7	**87**
08:00 AM	1	25	**4**	0	30	2	2	4	0	8	**6**	24	1	0	31	1	3	**4**	0	**8**	77
08:15 AM	2	21	2	0	25	**4**	1	3	0	8	4	13	0	0	17	0	1	0	0	1	51
08:30 AM	1	23	3	0	27	2	2	4	0	8	3	20	2	0	25	**5**	0	2	0	7	67
Total Volume	8	97	12	0	117	10	9	19	0	38	18	81	5	0	104	7	9	7	0	23	282
% App. Total	6.8	82.9	10.3	0		26.3	23.7	50	0		17.3	77.9	4.8	0		30.4	39.1	30.4	0		
PHF	.500	.866	.750	.000	.836	.625	.563	.594	.000	.679	.750	.844	.625	.000	.839	.350	.450	.438	.000	.719	.810
Peak Hour Analysis From 12:00 PM to 06:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	5	37	2	0	44	2	1	**4**	0	7	5	48	**4**	0	57	4	**11**	5	0	**20**	128
04:45 PM	**7**	**51**	0	0	**58**	2	**7**	1	0	**10**	2	53	1	0	56	2	5	**7**	0	14	**138**
05:00 PM	3	30	4	0	37	0	5	2	**1**	8	5	**61**	1	0	**67**	3	4	7	0	14	126
05:15 PM	6	23	**9**	0	38	**3**	2	2	0	7	**8**	49	3	0	60	**5**	4	7	0	16	121
Total Volume	21	141	15	0	177	7	15	9	1	32	20	211	9	0	240	14	24	26	0	64	513
% App. Total	11.9	79.7	8.5	0		21.9	46.9	28.1	3.1		8.3	87.9	3.8	0		21.9	37.5	40.6	0		
PHF	.750	.691	.417	.000	.763	.583	.536	.563	.250	.800	.625	.865	.563	.000	.896	.700	.545	.929	.000	.800	.929

APPENDIX B

Traffic Signal Warrant Analyses, 2016 and 2036

2016 SIGNAL WARRANTS ANALYSIS

LOCATION: TH 12 AT CSAH 34
COUNTY: MEEKER
REF. POINT:
DATE: 9/19/2016
OPERATOR: CW

Speed	Approach Description		Lanes
45	Major App1:	TH 12 EB	2
45	Major App3:	TH 12 WB	1
30	Minor App2:	CSAH 34 SB	1
	Minor App4:		

0.70 FACTOR USED? YES
POPULATION < 10,000? Yes
EXISTING SIGNAL ? No
THRESHOLDS 1A/1B: 420/630 105/52

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 1A/1B	**MET SAME 1A/1B**
0:00 - 1:00			0	/		/			**/**
1:00 - 2:00			0	/		/			**/**
2:00 - 3:00			0	/		/			**/**
3:00 - 4:00			0	/		/			**/**
4:00 - 5:00			0	/		/			**/**
5:00 - 6:00			0	/		/			**/**
6:00 - 7:00	182	91	273	/	44	/			**/**
7:00 - 8:00	200	188	388	/	70	/X			**/**
8:00 - 9:00	187	180	367	/	74	/X			**/**
9:00 - 10:00	232	226	458	X/	66	/X			**/**
10:00 - 11:00	292	254	546	X/	51	/			**/**
11:00 - 12:00	289	263	552	X/	71	/X			**/**
12:00 - 13:00	331	258	589	X/	71	/X			**/**
13:00 - 14:00	289	287	576	X/	77	/X			**/**
14:00 - 15:00	316	321	637	X/X	88	/X			**/X**
15:00 - 16:00	321	314	635	X/X	82	/X			**/X**
16:00 - 17:00	292	285	577	X/	75	/X			**/**
17:00 - 18:00	340	358	698	X/X	85	/X			**/X**
18:00 - 19:00	227	239	466	X/	78	/X			**/**
19:00 - 20:00			0	/		/			**/**
20:00 - 21:00			0	/		/			**/**
21:00 - 22:00			0	/		/			**/**
22:00 - 23:00			0	/		/			**/**
23:00 - 24:00			0	/		/			**/**

	Met (Hr)	Required (Hr)	
Warrant 1A	0	8	Not satisfied
Warrant 1B	3	8	Not satisfied
Warrant 2	0	4	Not satisfied
Warrant 3	0	1	Not satisfied
Warrant 7	**8**	8	**Satisfied, check accident record**

LOCATION: TH 12 AT CSAH 34
COUNTY: MEEKER
REF. POINT:
DATE: 9/19/2016
OPERATOR: CW

Speed	Approach Description	Lanes
45	Major App1: TH 12 EB	2
45	Major App3: TH 12 WB	1
30	Minor App2: CSAH 34 SB	1
	Minor App4:	

0.70 FACTOR USED? YES
POPULATION < 10,000? Yes
EXISTING SIGNAL ? No

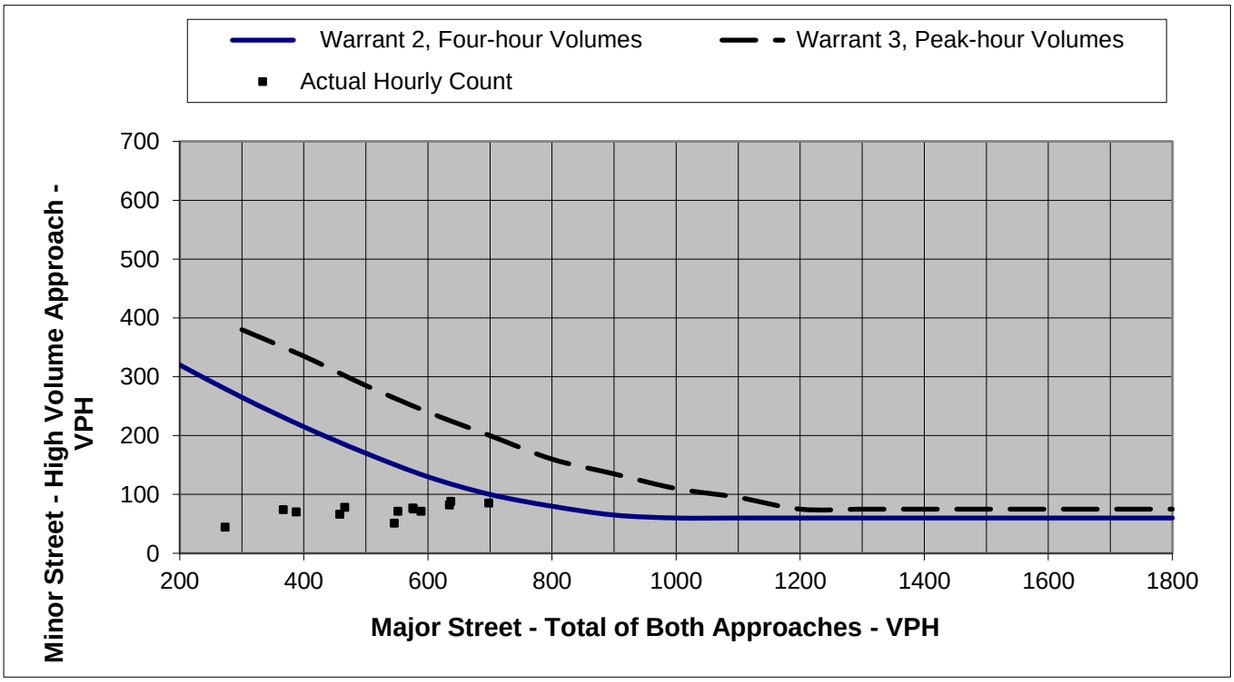


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria		
Major	Warrant 2, F	Warrant 3, Pe
200	320	
300	265	380
400	215	335
500	170	285
600	130	240
700	100	200
800	80	160
900	65	135
1000	60	110
1100	60	95
1200	60	75
1300	60	75
1400	60	75
1500	60	75
1600	60	75
1700	60	75
1800	60	75

Actual Hourly Count	
Major	Actual Hourly Count
0	0
0	0
0	0
0	0
0	0
0	0
273	44
388	70
367	74
458	66
546	51
552	71
589	71
576	77
637	88
635	82
577	75
698	85
466	78
0	0
0	0
0	0
0	0
0	0

2016 ALL WAY STOP WARRANT

LOCATION: TH 12 AT CSAH 34
COUNTY: MEEKER
REF. POINT:
DATE: 9/19/2016
OPERATOR: CW

Speed	Approach Description	Lanes
45	Major App1: TH 12 EB	2
45	Major App3: TH 12 WB	1
30	Minor App2: CSAH 34 SB	1
	Minor App4:	

0.70 FACTOR USED? Yes

					210	140	
HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR TOTAL Σ (APP. 1 & APP. 3)	MINOR TOTAL APP. 2 + APP. 4	WARRANT MET
0:00 - 1:00							
1:00 - 2:00							
2:00 - 3:00							
3:00 - 4:00							
4:00 - 5:00							
5:00 - 6:00							
6:00 - 7:00	182	91	44		273	44	X/
7:00 - 8:00	200	188	70		388	70	X/
8:00 - 9:00	187	180	74		367	74	X/
9:00 - 10:00	232	226	66		458	66	X/
10:00 - 11:00	292	254	51		546	51	X/
11:00 - 12:00	289	263	71		552	71	X/
12:00 - 13:00	331	258	71		589	71	X/
13:00 - 14:00	289	287	77		576	77	X/
14:00 - 15:00	316	321	88		637	88	X/
15:00 - 16:00	321	314	82		635	82	X/
16:00 - 17:00	292	285	75		577	75	X/
17:00 - 18:00	340	358	85		698	85	X/
18:00 - 19:00	227	239	78		466	78	X/
19:00 - 20:00							
20:00 - 21:00							
21:00 - 22:00							
22:00 - 23:00							
23:00 - 24:00							

	Met (Hr)	Required (Hr)	
Allway Stop Warrant:	0	8	Not satisfied

REMARKS:

2036 SIGNAL WARRANTS ANALYSIS

LOCATION: TH 12 AT CSAH 34
COUNTY: MEEKER
REF. POINT:
DATE: 10/5/2016
OPERATOR: CW

Speed	Approach Description		Lanes
45	Major App1:	TH 12 EB	2
45	Major App3:	TH 12 WB	1
30	Minor App2:	CSAH 34 SB	1
	Minor App4:		

0.70 FACTOR USED? YES
POPULATION < 10,000? Yes
EXISTING SIGNAL ? No
THRESHOLDS 1A/1B: 420/630 105/52

HOUR	MAJOR APP. 1	MAJOR APP. 3	TOTAL 1+3	MAJOR 1A/1B	MINOR APP. 2	MINOR 2 1A/1B	MINOR APP. 4	MINOR 4 1A/1B	**MET SAME 1A/1B**
0:00 - 1:00			0	/		/			**/**
1:00 - 2:00			0	/		/			**/**
2:00 - 3:00			0	/		/			**/**
3:00 - 4:00			0	/		/			**/**
4:00 - 5:00			0	/		/			**/**
5:00 - 6:00			0	/		/			**/**
6:00 - 7:00	294	187	481	X/	42	/			**/**
7:00 - 8:00	324	364	688	X/X	67	/X			**/X**
8:00 - 9:00	320	335	655	X/X	70	/X			**/X**
9:00 - 10:00	385	410	795	X/X	63	/X			**/X**
10:00 - 11:00	470	476	946	X/X	49	/			**/**
11:00 - 12:00	464	501	965	X/X	68	/X			**/X**
12:00 - 13:00	534	485	1019	X/X	68	/X			**/X**
13:00 - 14:00	486	560	1046	X/X	73	/X			**/X**
14:00 - 15:00	512	611	1123	X/X	84	/X			**/X**
15:00 - 16:00	535	624	1159	X/X	78	/X			**/X**
16:00 - 17:00	493	587	1080	X/X	71	/X			**/X**
17:00 - 18:00	581	725	1306	X/X	81	/X			**/X**
18:00 - 19:00	385	136	521	X/	74	/X			**/**
19:00 - 20:00			0	/		/			**/**
20:00 - 21:00			0	/		/			**/**
21:00 - 22:00			0	/		/			**/**
22:00 - 23:00			0	/		/			**/**
23:00 - 24:00			0	/		/			**/**

	Met (Hr)	Required (Hr)	
Warrant 1A	0	8	Not satisfied
Warrant 1B	**10**	8	**Satisfied**
Warrant 2	7	4	**Satisfied**
Warrant 3	1	1	**Satisfied**
Warrant 7	**12**	8	**Satisfied, check accident record**

LOCATION: TH 12 AT CSAH 34
COUNTY: MEEKER
REF. POINT:
DATE: 10/5/2016
OPERATOR: CW

Speed	Approach Description	Lanes
45	Major App1: TH 12 EB	2
45	Major App3: TH 12 WB	1
30	Minor App2: CSAH 34 SB	1
	Minor App4:	

0.70 FACTOR USED? YES
POPULATION < 10,000? Yes
EXISTING SIGNAL ? No

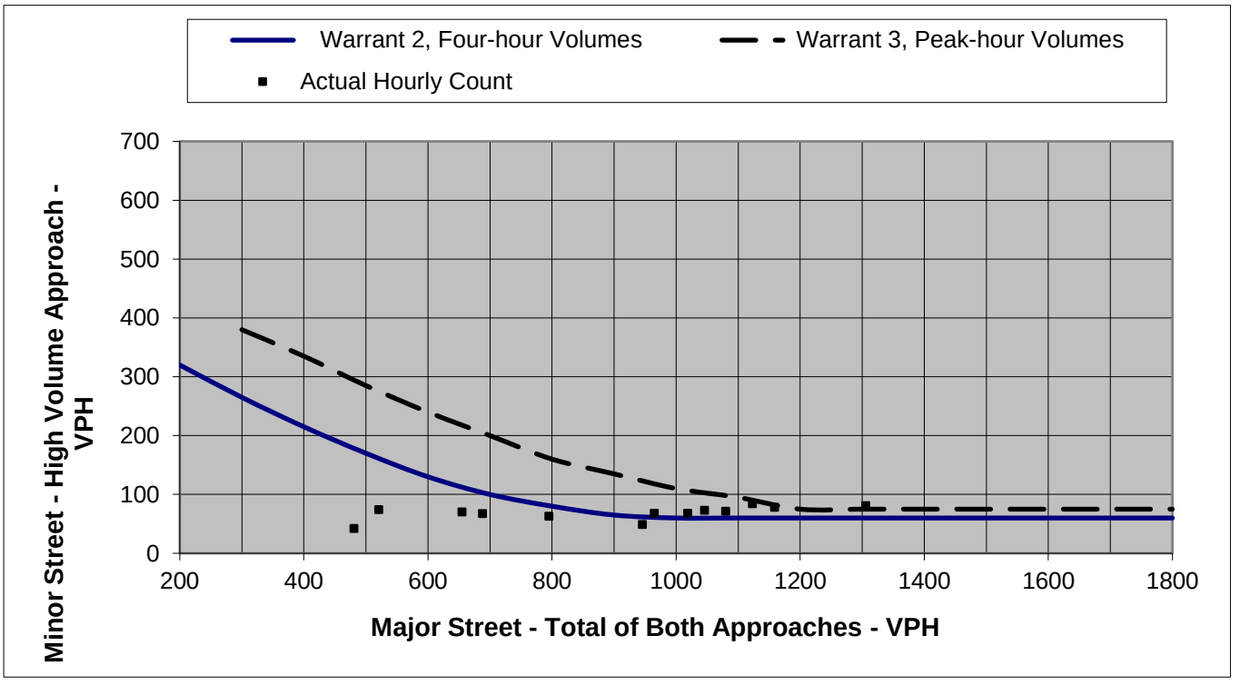


Figure 1. Four Hour and Peak Hour Warrant Analysis

Note: For data points outside the graph range, check the minor street volume against the lower thresholds

Warrant Criteria		
Major	Warrant 2, F	Warrant 3, Pe
200	320	
300	265	380
400	215	335
500	170	285
600	130	240
700	100	200
800	80	160
900	65	135
1000	60	110
1100	60	95
1200	60	75
1300	60	75
1400	60	75
1500	60	75
1600	60	75
1700	60	75
1800	60	75

Actual Hourly Count	
Major	Actual Hourly Count
0	0
0	0
0	0
0	0
0	0
0	0
481	42
688	67
655	70
795	63
946	49
965	68
1019	68
1046	73
1123	84
1159	78
1080	71
1306	81
521	74
0	0
0	0
0	0
0	0
0	0

2036 ALL WAY STOP WARRANT

LOCATION: TH 12 AT CSAH 34
COUNTY: MEEKER
REF. POINT:
DATE: 10/5/2016
OPERATOR: CW

0.70 FACTOR USED? Yes

Speed	Approach Description	Lanes
45	Major App1: TH 12 EB	2
45	Major App3: TH 12 WB	1
30	Minor App2: CSAH 34 SB	1
	Minor App4:	

					210	140	
HOUR	MAJOR APP. 1	MAJOR APP. 3	MINOR APP. 2	MINOR APP. 4	MAJOR TOTAL Σ (APP. 1 & APP. 3)	MINOR TOTAL APP. 2 + APP. 4	WARRANT MET
0:00 - 1:00							
1:00 - 2:00							
2:00 - 3:00							
3:00 - 4:00							
4:00 - 5:00							
5:00 - 6:00							
6:00 - 7:00	294	187	42			42	/
7:00 - 8:00	324	364	67			67	/
8:00 - 9:00	320	335	70			70	/
9:00 - 10:00	385	410	63			63	/
10:00 - 11:00	470	476	49			49	/
11:00 - 12:00	464	501	68			68	/
12:00 - 13:00	534	485	68			68	/
13:00 - 14:00	486	560	73			73	/
14:00 - 15:00	512	611	84			84	/
15:00 - 16:00	535	624	78			78	/
16:00 - 17:00	493	587	71			71	/
17:00 - 18:00	581	725	81			81	/
18:00 - 19:00	385	136	74			74	/
19:00 - 20:00							
20:00 - 21:00							
21:00 - 22:00							
22:00 - 23:00							
23:00 - 24:00							

	Met (Hr)	Required (Hr)	
Allway Stop Warrant:	0	8	Not satisfied

REMARKS:

APPENDIX C
Operational Analysis

TH 12 at CSAH 34
Traffic Operations Analysis

Traffic Operations Analysis at TH 12/CSAH 34

Traffic Control Scenario	Access	Peak Hour	Intersection Delay - LOS		SB Delay - LOS		EBL Delay - LOS		EBT Delay - LOS		WBT Delay - LOS		WBR Delay - LOS		SB Max Queue (ft)	EB Max Queue (ft)	WB Max Queue (ft)
Build Year 2016																	
No Build	**Full**	AM	10	A	10	A	2	A	1	A	2	A	1	A	74	41	4
		PM	14	B	14	B	4	A	1	A	2	A	2	A	123	57	13
Add Turn Lanes	**Full**	AM	10	A	10	A	2	A	1	A	2	A	1	A	67	44	4
		PM	14	B	14	B	4	A	1	A	2	A	2	A	91	61	13
Traffic Signal	**Full**	AM	9	A	9	A	4	A	3	A	5	A	2	A	73	83	98
		PM	11	B	11	B	5	A	4	A	6	A	3	A	75	87	119
Roundabout	**Full**	AM	6	A	6	A	-	-	7	A	7	A	-	-	25	50	50
		PM	10	B	7	A	-	-	9	A	10	B	-	-	25	50	75
Green "T"	**Full**	AM	16	B	16	B	8	A	1	A	8	A	2	A	76	54	134
		PM	19	B	19	B	14	B	1	A	9	A	3	A	106	69	142
RCI	**Partial**	AM	32	C	32	C	2	A	0	A	1	A	1	A	65	39	8
		PM	34	C	34	C	5	A	0	A	2	A	2	A	100	53	26
RIRO	**Partial**	AM	32	C	32	C	27	C	1	A	0	A	0	A	70	-	-
		PM	34	C	34	C	28	C	1	A	1	A	0	A	87	-	-
Design Year 2036																	
No Build	**Full**	AM	22	C	22	C	4	A	1	A	3	A	2	A	136	51	9
		PM	228	F	228	F	10	B	1	A	1	A	0	A	591	86	22
Add Turn Lanes	**Full**	AM	22	C	22	C	5	A	1	A	3	A	2	A	111	55	18
		PM	208	F	208	F	12	B	1	A	4	A	3	A	418	103	27
Traffic Signal	**Full**	AM	12	B	12	B	6	A	4	A	8	A	3	A	93	104	137
		PM	19	B	19	B	12	B	5	A	11	B	5	A	118	146	248
Roundabout	**Full**	AM	12	B	8	A	-	-	12	B	12	B	-	-	25	100	100
		PM	33	C	12	B	-	-	19	B	33	C	-	-	50	200	350
Green "T"	**Full**	AM	19	B	19	B	13	B	1	A	9	A	2	A	96	73	201
		PM	28	C	24	C	28	C	1	A	12	B	4	A	158	135	286
RCI	**Partial**	AM	35	C	35	C	4	A	1	A	2	A	2	A	67	62	4
		PM	41	D	41	D	9	A	1	A	3	A	3	A	150	160	22
RIRO	**Partial**	AM	35	C	35	C	27	C	1	A	1	A	1	A	78	-	-
		PM	45	D	45	D	27	C	1	A	2	A	1	A	187	-	-

BOLTON & MENK

Real People. Real Solutions.

APPENDIX D
Crash Analysis

Intersection Safety Screening

Intersection: TH 12 at CSAH 34

Crash Data, 2013-2015.

Crashes by Crash Severity	
Fatal	0
Incapacitating Injury	0
Non-incapacitating Injury	0
Possible Injury	4
Property Damage	4
Total Crashes	8

Intersection Characteristics	
Entering Volume	9,125
Traffic Control	Thru / stop
Environment	Suburban
Speed Limit	45 mph

Annual crash cost = $120,800

Statewide Comparison *Urban Thru / Stop*

Total Crash Rate	
Observed	0.80
Statewide Average	0.19
Critical Rate	0.59
Critical Index	**1.36**

Fatal & Serious Injury Crash Rate	
Observed	0.00
Statewide Average	0.33
Critical Rate	7.67
Critical Index	**0.00**

The observed crash rate is the number of crashes per million entering vehicles (MEV). The critical rate is a statistical comparison based on similar intersections statewide. An observed crash rate greater than the critical rate indicates that the intersection operates outside the expected, normal range. The critical index reports the magnitude of this difference.

The observed total crash rate for this period is 0.80 per MEV; this is 1.4 times the critical rate. If crashes were reduced by 2 over three years, this intersection would perform within normal range.

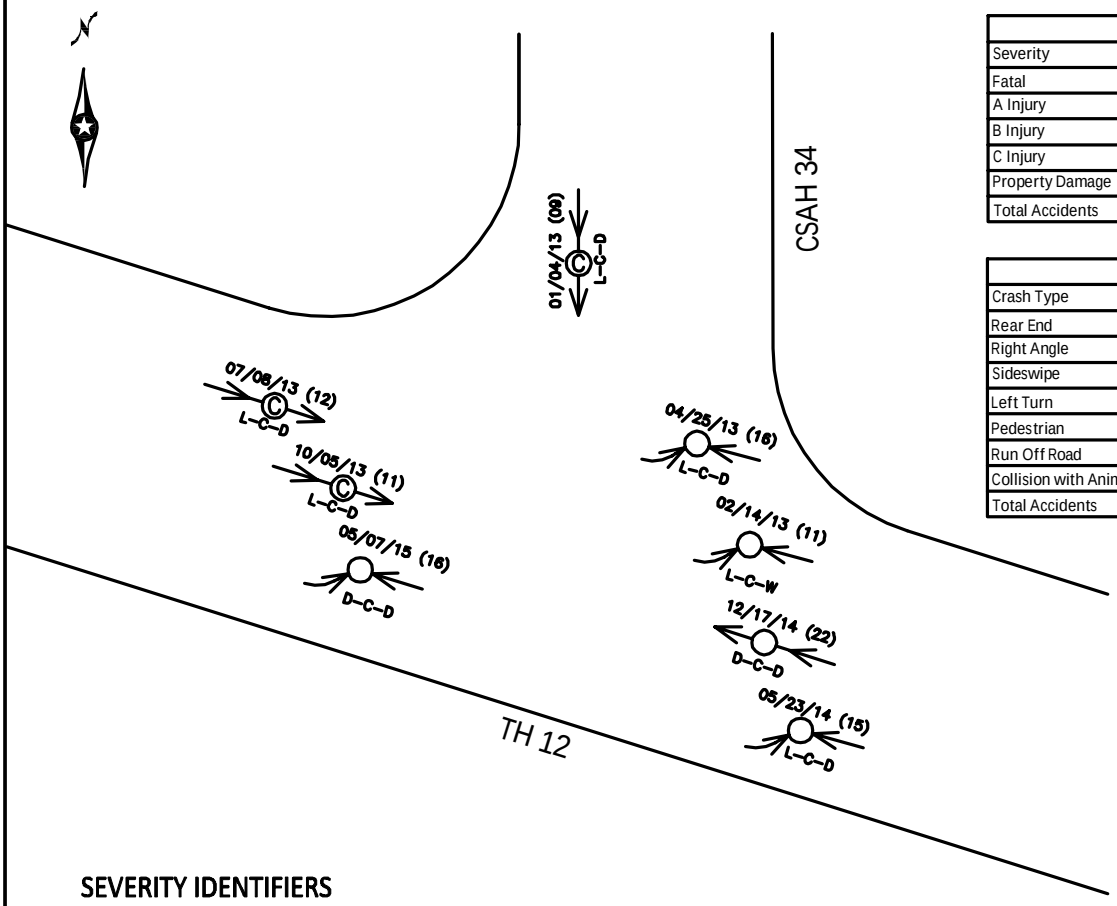
The observed fatal and serious injury crash rate for this period is 0.00 per 100 MEV; this is 100% below the critical rate. The intersection operates within the normal range.

COLLISION DIAGRAM

LOCATION: TH 12 AT CSAH 34

TIME PERIOD: 01/01/2013 - 12/31/2015 DATE: 09/19/16

PREPARED BY: C.WU



	Year		
Severity	2013	2014	2015
Fatal	0	0	0
A Injury	0	0	0
B Injury	0	0	0
C Injury	4	0	0
Property Damage	1	2	1
Total Accidents	5	2	1

	Year		
Crash Type	2013	2014	2015
Rear End	3	1	0
Right Angle	0	0	0
Sideswipe	0	0	0
Left Turn	2	1	1
Pedestrian	0	0	0
Run Off Road	0	0	0
Collision with Animal	0	0	0
Total Accidents	5	2	1

SEVERITY IDENTIFIERS

- ● Fatal Acc.
- Ⓐ Ⓑ Ⓒ Personal Injury
- ○ Property Damage Acc.

KEY

- Motor Vehicle Backing Up
- Motor Vehicle Out of Control
- Motor Vehicle Ahead
- Rear End
- Right Angle
- Pedestrian
- Bicycle/Moped
- Motorcycle
- Left Turn
- Fixed Object

NOTES

[1] ADT = 9,125

[2] CR = 0.80

[3] SR = 0

Light:
L= Daylight (1)
DN= Dawn (2)
DU= Dusk (3)
DI= Dark, Lighted (4)
Do= Dark, Lights Off (5)
D= Dark, Unlighted (6)

Weather:
C= Clear or Cloudy (1 or 2)
R= Rain (3)
S= Snow or Sleet (4 or 5)
F= Fog, Smog, Smoke (6)
B= Blowing Sand/Dust (7)
W= Severe Crosswinds (8)

Surface:
D= Dry (1)
W= Wet (2)
S= Snow or Ice (3 or 4)
M= Muddy (5)
DB= Debris (6)
O= Oily (7)

BOLTON & MENK
12224 NICOLLET AVENUE
BURNSVILLE, MINNESOTA 55337
Phone: (952) 890-0509
Email: Burnsville@bolton-menk.com
www.bolton-menk.com

INTERSECTION CONTROL EVALUATION

TH 12 AT CSAH 34

FIGURE 3: COLLISION DIAGRAM

Drawing name: H:\MDOT\T42M00040\2_Preliminary\C_Reports\CE Report\2_Appendices\Appendix B\Crash Diagram.dwg -- Printed: Oct 18, 2016 - 3:24pm

Crash Detail Report

TH 12 & CASH 34

Report Version 1.0 March 2010

Crash ID: 130040159 **Date:** 01/04/2013 **Time:** 0946
County: MEEKER **City:** LITCHFIELD

Sys: 04-CSAH
Route: 47000034 000+00.000

Severity: POSSIBLE INJURY
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED

First Event: ON ROADWAY
To Junction: T-INTERSECTION
Traffic Device: STOP SIGN OTHER
Speed Limit: 30
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	S	S	
Veh Act:	STOPPED TRAFFIC	STOPPED TRAFFIC	
Veh Type:	PASSENGER CAR	SPORT UNTILITY VEHICLE	
Age:	49	26	
Gender:	F	F	
Cond:	NORMAL	NORMAL	
Cont Fact 1	NO IMPROPER DRIVING	FOLLOWING TOO CLOSELY	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 130450175 **Date:** 02/14/2013 **Time:** 1106
County: MEEKER **City:**

Sys: 02-US
Route: 00000012 102+00.101

Severity: PROPERTY DAMAGE
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: WET
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED

First Event: ON ROADWAY
To Junction: 4-LEGGED INTERSECTION
Traffic Device: STOP SIGN OTHER
Speed Limit: 45
Diagram: RIGHT ANGLE
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	W	S	
Veh Act:	STRAIGHT AHEAD	LEFT TURN	
Veh Type:	PASSENGER CAR	PASSENGER CAR	
Age:	66	59	
Gender:	M	M	
Cond:	NORMAL	NORMAL	
Cont Fact 1	NO IMPROPER DRIVING	FAIL TO YIELD ROW	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 131160028 **Date:** 04/25/2013 **Time:** 1632
County: MEEKER **City:**

Sys: 02-US
Route: 00000012 102+00.101

Severity: POSSIBLE INJURY
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED

First Event: ON ROADWAY
To Junction: 4-LEGGED INTERSECTION
Traffic Device: STOP SIGN OTHER
Speed Limit: 45
Diagram: RIGHT ANGLE
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	W	SE	
Veh Act:	STRAIGHT AHEAD	LEFT TURN	
Veh Type:	PASSENGER CAR	SPORT UNTILITY VEHICLE	
Age:	23	75	
Gender:	M	F	
Cond:	NORMAL	NORMAL	
Cont Fact 1	NO IMPROPER DRIVING	FAIL TO YIELD ROW	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 131920233 **Date:** 07/08/2013 **Time:** 1254
County: MEEKER **City:**

Sys: 02-US
Route: 00000012 102+00.101

Severity: POSSIBLE INJURY
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED

First Event: ON ROADWAY
To Junction: NON-JUNCTION
Traffic Device: OFFICER/FLAGMAN/SCHOOL
Speed Limit: 30
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 4.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	EAST	E	EAST
Veh Act:	STRAIGHT AHEAD	SLOWING TRAFFIC	STOPPED TRAFFIC
Veh Type:	TRUCK W/ SEMI TRAILER	PASSENGER CAR	2-AXLE TRUCK/SETP VAN
Age:	63	19	47
Gender:	M	M	M
Cond:	NORMAL	NORMAL	NORMAL
Cont Fact 1	ILLEGAL SPEED	FOLLOWING TOO CLOSELY	NO IMPROPER DRIVING
Cont Fact 2	FOLLOWING TOO CLOSELY	NOT SPECIFIED	NOT SPECIFIED

Crash ID: 132790089 **Date:** 10/05/2013 **Time:** 1149 **Sys:** 02-US
County: MEEKER **City:** **Route:** 00000012 102+00.101

Severity: POSSIBLE INJURY
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED
First Event: ON ROADWAY
To Junction: NON-JUNCTION
Traffic Device: NOT APPLICABLE
Speed Limit: 40
Diagram: REAR END
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	EAST	E	
Veh Act:	LEFT TURN	STRAIGHT AHEAD	
Veh Type:	PASSENGER CAR	PASSENGER CAR	
Age:	69	19	
Gender:	F	M	
Cond:	NORMAL	NORMAL	
Cont Fact 1	NO IMPROPER DRIVING	DISTRACTION	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 141470028 **Date:** 05/23/2014 **Time:** 1557 **Sys:** 02-US
County: MEEKER **City:** **Route:** 00000012 102+00.101

Severity: PROPERTY DAMAGE
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DAYLIGHT
Weather 1: CLEAR
Weather 2: NOT SPECIFIED
First Event: ON ROADWAY
To Junction: T-INTERSECTION
Traffic Device: STOP SIGN OTHER
Speed Limit: 30
Diagram: RIGHT ANGLE
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	EAST	W	
Veh Act:	LEFT TURN	STRAIGHT AHEAD	
Veh Type:	VAN OR MINIVAN	PASSENGER CAR	
Age:	65	16	
Gender:	F	M	
Cond:	NORMAL	NORMAL	
Cont Fact 1	FAIL TO YIELD ROW	NO IMPROPER DRIVING	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	

Crash ID: 143520001 **Date:** 12/17/2014 **Time:** 2238
County: MEEKER **City:** LITCHFIELD

Sys: 04-CSAH
Route: 47000034 000+00.001

Severity: PROPERTY DAMAGE
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: DRY
Light Cond: DARK - NO STREET LIGHTS
Weather 1: CLEAR
Weather 2: NOT SPECIFIED

First Event: ON ROADWAY
To Junction: T-INTERSECTION
Traffic Device: NOT APPLICABLE
Speed Limit: 45
Diagram: RIGHT ANGLE
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	W	W	
Veh Act:	RIGHT TURN	STRAIGHT AHEAD	
Veh Type:	PASSENGER CAR	TRUCK W/ SEMI TRAILER	
Age:	16	58	
Gender:	F	M	
Cond:	NORMAL	NORMAL	
Cont Fact 1	OVER CENTERLINE	NO IMPROPER DRIVING	
Cont Fact 2	VISION OBSCURED - WINDSHIEL	NOT SPECIFIED	

Crash ID: 151270031 **Date:** 05/07/2015 **Time:** 1654
County: MEEKER **City:**

Sys: 02-US
Route: 00000012 102+00.101

Severity: PROPERTY DAMAGE
Road Type: 2 LANES UNDIV 2_WAY
Road Char: STRAIGHT AND LEVEL
Crash Type: COLL W/MV IN TRANSPORT
Surf Cond: WET
Light Cond: DAYLIGHT
Weather 1: RAIN
Weather 2: NOT SPECIFIED

First Event: ON ROADWAY
To Junction: T-INTERSECTION
Traffic Device: STOP SIGN OTHER
Speed Limit: 45
Diagram: LEFT TURN INTO TRAFFIC
Officer:
Reliability: CONFIDENT
# of Vehicles: 2.00

	Unit 1	Unit 2	Unit 3
Trav Dir:	SE	E	
Veh Act:	LEFT TURN	STRAIGHT AHEAD	
Veh Type:	PASSENGER CAR	PASSENGER CAR	
Age:	20	61	
Gender:	M	M	
Cond:	NORMAL	NORMAL	
Cont Fact 1	FAIL TO YIELD ROW	OTHER HUMAN FACTOR	
Cont Fact 2	NOT SPECIFIED	NOT SPECIFIED	